Civil Engineering Education.

DISCUSSION.

(*Continued from page* 38).

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Prof. Waddell's paper contains so many good things and raises so many questions that I can only briefly notice a few. The practical question with teachers is not so much what is the ideal course, as how best to approximate to such a course under special conditions and restrictions. Of these restrictions, lack of means is by far the most important and will, I think, be found to be the direct or indirect cause of nearly all the exceptions and criticisms which are usually made as to methods of teaching and scope of instruction. The whole question thus narrows down in practice, to how can one do the best with the means at command. Given so much teaching force, so much time and so much plant, how can so many students be best prepared? This is as much a question of skillful engineering as any likely to arise in the engineers practice, and for its best solution in any special case a clear idea apart from any limitations, of what should be aimed at and of the general principles which should guide are of the first importance. In this respect Prof. Waddell's paper seems to me of much value and full of good suggestions by which I for one hope to profit. I think I see in it the evidence of the thorough teacher and of an experience quite exceptional in some respects.

The first requisite is of course money. Insufficiency of means, implies lack of ability in teachers, inadequate teaching force and plant, and insufficient time given to the course. I need hardly dwell on these points. They account in themselves for nearly all the faults and short comings which our courses suffer from. They are not, however, of equal importance. A real teacher is "born not made." At least unless he brings to his work that enthusiasm and special fitness and tact essential in any calling to real success, he is out of place and not the most eminent professional ability or experience can make of him a good or even desirable teacher, no matter how accomplished as an engineer he may be.

This point has not usually, I think, been insisted upon as strongly as it deserves. If, with unlimited means, our schools could call to their aid the first professional talent in the country, it is open question just how much would to-day be gained by the students. Not every one can *teach* even that which he has thoroughly mastered, and instances of eminent learning and brilliant talents all but wasted in the Professor's chair have been frequent enough to enforce this point. I am free to assert that in this respect, lack of means is not so responsible for results as many suppose, and that mediocre ability in those who fill the chairs in our Technical Institutions is not the most noticeable evil. The true teacher finds his place in this direction, as in all others, and neither insufficient salary nor cramped facilities can keep him out, although they may cripple his efforts. To the born teacher there are compensations not measured in money. His vocation is the noblest and his rewards are of the highest. He has found his home in our schools, he has "come to stay,' and his work is going over the land and will speak for him.

Inadequate plant is a more important limitation, but in most of our well appointed institutions I think it will be found, that if the plant is not all that could be desired, yet with skillful management it suffices for good, if not for the best results. Increased means well administered, would undoubtedly do much for us in both the preceding directions, but I would not put the main stress upon them.

If I wished to point out the weakest spot in all our institutions, I should confine my remarks to inadequate *teaching force and time*. Here, I think, is the place for reform, here first I would apply the means I covet, and here I would look for the cause and the remedy of those faults in method, system, curriculum and what not, which lie so open to the captious, of which we are ourselves so well aware, and which we are all trying so hard, and as some think, so vainly, to eliminate.

A teacher's capacity to teach is inversely as the numbers he has to instruct. A "born teacher" say, is doing good work with good facilities, along a well proportioned course. Now then, double the number of his pupils, and other things do not remain the same. His facilities are now inadequate, his whole course thrown out of gear, his methods must perforce entirely change. He spreads out too thin. His personality will not go round. His character, individuality and enthusiasm lose their inspiring power. The nice touch of mind on mind, which is more to the pupil even than the knowledge imparted—the *educating* power—is weakened, and then methods become perfunctory, "marks" and "discipline" the necessary adjuncts to "machine teaching," make their appearance and the inevitable sequence of "cuts" and "skinning" follows. Here is the crying evil, and its consequences are myriad, and run through the whole system, lowering the standard of admission, working back upon the preparatory schools and forward through the whole course to final examination and to graduation. The teaching force, first of all and above all, must be kept adequate to the number of students. As civil engineering breaks up with the growing requirements of the day, into specialty after specialty, the teaching force must keep abreast of the requirements of the times. No one man or two men will do, but many permanent chairs must be kept filled and co-operating.

The fact is, we have gone ahead too fast in this country and tried to build from the top down. Instead of a thorough preparatory school system as a basis for all our higher institutions, we have commenced with the higher institutions, and based them upon the shifting sand of private tuition, and irresponsible, unorganized, unsystematic and disconnected "private schools," where a dozen boys are "prepared" at the same time for as many different institutions with as many differing standards and requirements. Then, in our higher institutions themselves, we have handsome buildings and expensive dormitories, and extravagant exteriors, with very often meagre equipment, and nearly always insufficient teaching force. Too much for show, and too little for work. The first duty of a college is to *teach*—to lodge its students in palaces of brick, and brown-stone is not of such immediately pressing importance.

Next in order I would put lack of time. Our students partaking of the spirit of the age, are in a hurry also. They want to get out as soon as possible and go to work. Thus our courses are crowded and curtailed. Not until these two points are attended to, and remedied, can we even begin to discuss with profit such questions of detail as curriculum and methods of instruction. Indeed, I firmly believe that if these two points were remedied, there would in a short time be very substantial agreement, and little to criticize on all these minor points. The greater includes the less, and we would do well in our discussion of this whole question to aim steadily at the center. My plea is then in brief, give us money. Money for more teachers, money for more time. Time and teachers—not increased salaries, we do not ask even for that, but only more of such as we already have, and more time to work in. Give us these for a few years, and it requires no great boldness to predict that methods of instruction will better keep pace with the strides of engineering practice. Beyond these, we ask, and should have, sufficient means to keep up the plant and facilities to full efficiency, and to be *independent of numbers*.

No institution should depend upon its tuition fees if it is to do its best work. Directors and teachers—even "born teachers," are human, and thoroughness of instruction, rigor of examinations and sufficiency of salaries, should not be dictated by temporary policy, or affected by popularity, nor should the successful working of an institution be gauged by its numbers, only. Those who recognize only "success," would do well to define what they mean by the word, and to keep its necessary conditions ever in mind if they wish to justly estimate the problem our teachers are working out. To run a large institution in the best way and in the most economical way, to keep and attract students and yet enforce the necessary discipline, to pay salaries and preserve a high standard, is a problem not to be solved by off-hand discussion.

In this respect of entire independence of tuition fees, and also in their system of mutual co operation which allows a student to freely pass from one to another in pursuit of special excellences, as well as in the thorough system of preparatory schools on which they are based, would I copy the institutions of Germany—and in no others. In other respects we may, I think, learn from them what to avoid. We do *not* wish our professors, as in Germany, to give a course of instruction upon one topic, as if that one topic were the chief and only one of importance to all the students whatever their aims. The relation of the topics to one another, their proper subordination to the entire course the student wishes to take, and the perspective of the course itself, are thus lost. Our professors must combine their forces for the special end the *student* has in view, and work in concert to that end. Not, as abroad, teach the civil engineering students geology for instance, as if their aim were to become specialists in that one subject alone, or mathematics, as if their aim in life was to master quaternions; but measure the courses to the requirements of the section they instruct. Again, we do *not* wish our students as in Germany, to run wild at their own sweet will, without oversight, discipline, or pressure of any kind, and without the remotest personal contact with the men who should mould not their minds alone but their disposition and character as well. Our system here has grown up naturally to suit our soil, and should continue to grow and develop in accordance with its environment, and not be transplanted by force from a strange soil and made to suit different requirements. We acknowledge in this country responsibility to parent as well as to student, and rightly feel to the fullest extent the importance to the student of guidance as well as of instruction. No one who has seen the facility and rapid and masterly ease with which a well disposed, rather ill-trained, American youth transplanted too young to the soil of a German university can make the "descent to *Avernus*," would wish to copy *this* feature of the "University" until at least we have the same sound basis of preparatory schools to rest upon.

Finally, we do *not* wish to imitate the lecture system of the German university. For finely prepared, earnest and matured students, there is nothing more stimulating than the *viva voce* instruction of a master, fitted by learning, enthusiasm and love for his subject, and by brilliant talents. True teaching of the very highest order is here. Enthusiasm begets its like, mind answers to mind, and lessons are learned which are not to be found in books. There is no one who has benefitted by such instruction, who would not wish to impart it if he could. But he is the wise teacher who recognizes its limitations and its requirements. Lack of co-ordination in the professors; "*Academische Freiheit*," and the "lecture system," pure and simple, are characteristics of the university abroad which we do not need to copy at home. A union of text-books, of recitations and of lectures in proportions to be determined by the character of the class and the teacher's own ability, would seem the wisest and best method and the necessity of some system of dicipline which will brace up a flagging or indolent student under such a system is obvious. Hence the "marking system," which is the cause in unwise hands of so much evil, which is so easily liable to abuse, and yet which seems in some form so necessary. The best solution would seem to be that the student should not know nor care to know his "mark." It is simply the convenient method by which the teacher can grade the students' standing and work, and upon the basis of which he may decide as to the student's progress and his fitness to continue the course, or may give needed and timely warning to the parents. This much seems necessary, and more seems unadvisable. If grading by scholarship is necessary, that should not depend upon "marks" alone. But the existence of such marks will be no hindrance to the teacher in deciding.

Finally, the teacher, not over burdened by the size of his division, can come into and should earnestly seek personal relations and personal contact, should encourage, criticise and warn, and learn the personal wants and individual character of the student. So far from antagonism, there should be warm and close relations, and the experience, I am confident, of every good teacher, is that nothing is so easy to gain, as the confidence, good will and hearty admiration of a well disposed, ingenuous student or more richly repays the little trouble required to get it. An *esprit de corps* is thus guaranteed which recognizes the teacher's difficulties, appreciates his labors and frowns down dishonest practices. Friendships are formed which endure beyond the class room and the most prized rewards of the teacher's vocation very often meet him from this direction. I speak from experience here, that which I do know, and to any teacher reading this who doubts the fact, I simply say, "try and see." Barren must the record of that teacher's life be which has nothing to tell of such rewards. The teacher whose work and responsibility ends when he has heard his recitation and recorded his "marks" or delivered his lecture, is a man out of place, who knows not the true dignity of his vocation. I look back now on over ten years of work in the class room, and dismal would be the retrospect and more dreary the prospect if my sole rewards were found in my salary and in perfunctory work alone. As it is, had I my life to live over and my choice again to make, in view of much that is drudgery and much that I might hope to achieve in other directions, in spite of low salary and much that is discouraging and disheartening, in spite of hampering limitations and the consequent disatisfaction which must always attend the performance of work below one's ideal and best abilities, remembering the rewards which have come to me—rewards not measured in money value, and the many satisfactions of mutual help and kindliness with those I have guided—I could not but choose again the same path.

That the activities of the good teacher, not overburdened with numbers or class exercises, will not end with his class, goes without saying. It is impossible to meet fairly the inquiries of fresh young minds, to go over and over, with care and thoroughness, fundamental principles, and to try yearly to bring out with clearness their best and freshest applications, without one's own mind being stimulated and quickened to productive work. Still, these activities should, and I think generally do, be more in the line of research and of inquiry rather than in the lines of practical operation. The teacher cannot pursue his vocation with one hand and put money in his purse with the other. No half-hearted allegiance should be tolerated. Let the active members of his profession erect their structures, *his* work lies in perfecting the science which

those structures illustrate, and in sending out men familiar with its results.

As to the details of the curriculum, it must be borne in mind that engineering is both a science and an art. As a science, the school and teacher can do much to train the student in the comprehension, grasp and use of its principles and laws. This should be as broad and full and thorough as the time and abilities of the teacher can make it. Nothing should be allowed to curtail this. The art, or methods of application, on the other hand, should, in the school, be subsidiary and illustrative—selected for their tonic effect and for the point they give to the training in the principles—so that these may be in no danger of losing vitality or becoming too abstract. Everywhere they should tie the student down to the fact that what he learns he must *use*, and in every case he must apply his principles thoroughly and in practical detail. But it is not necessary that such applications should be very numerous or multiplied, if only their scope be wide. The object is not skill in the doing—that will come in after life—but skill in the *applying*. A few well-chosen applications, thoroughly done, are better than myriads of detached applications repeated for the sake of mere manual facility. In field work or designing, a single location well worked up and completed, a single design thoroughly executed, with every side issue and every question arising in the progress of the work followed up and settled, are better than many miles run and much paper spoiled. Slow, steady, intelligent, painstaking application of principles, everywhere searching the why and wherefore, should be the aim of these practical applications. The habit of thinking, of understanding, of applying knowledge recently acquired is the end sought, not rapid execution or showy results, and the student thus taught by contact with practice, how much must depend always upon himself, his intelligence and "common sense," how much there is which books and formulæ cannot include, in short, how true and vital is the saying attributed to one of our foremost engineers, that "it takes nine pounds of common sense to apply one pound of science."

Even though such applications should not perchance meet the requirements of the most recent field practice, or even be "antiquated," I venture to think that thus taught, the effect and result will be more valuable in after practice than a mere superficial practice of even the most approved modern method on a hasty scale. The habit of understanding and of thorough honest work will not fail a student in need, and even though he may never have heard of "grade plugs," nor be up in the latest method of keeping field notes, nor the shortest cuts in figuring earthwork, he can well stand the temporary embarassment and yet come out finally and quickly well to the fore. Art is long, but sound principles, soundly applied and thoroughly mastered, are the best introduction to any handicraft.

With Professor Waddell I would draw the line in mathematics at the calculus. The engineer is required to *use* the mathematics and he should find in them a ready tool. But he is not expected to pursue the mathematics as a specialty nor to develop them as a science. If any problems in civil engineering call necessarily for any higher mathematics than the more simple applications of the integral calculus, I know of none. In the study of this subject applications and principles should go hand in hand. To lose sight of practical use and bearing is here very easy and very disastrous. Nowhere does the student stand more in danger of letting his reasoning powers lie dormant and relying upon memory, and the very facility of the instrument and its processes are apt to cause him to lose sight of the ideas, relations and logic with which he is dealing.

Time must put an end to these hasty remarks. Professor Waddell has given us all much to think of, and in his paper are many hints and suggestions, the result of the experience of a thorough teacher dealing with an exceptionally fine class of students, which will not be without fruit.

To those in the active pursuit of their profession to whom the courses of instruction as existing in our technical schools may appear deficient, especially to those of this class who have themselves taken such courses, there may well seem much to criticise. No one can realize this more than those in charge of such instruction. Much may well have occurred to them even before the graduation of those now ready and qualified to point out such deficiences, if such criticism go to the root and show the reason and point out the remedy, all engaged in the profession of teaching can only welcome and encourage it. In this spirit we join hands But to all I would most earnestly say, search and see if most if not all of the serious shortcomings are not directly or indirectly due to lack of teaching force. If so, let us not lose sight of the cause in the symptoms. When we call to mind that the entire technical education of this great country rests almost wholly upon the free gifts of private munificence, we may well be proud of what has been accomplished, and have confidence in the future of a system unique in the history of the world. Let those who have built it up have due credit. The record of the administration of this great trust can only welcome investigation, and justifies the belief that the result can only be an increase of that public confidence and intelligent generosity to which it owes its existence.

Metallic Railway Track.

Translated for ENGINEERING NEWS.

BY E. E. RUSSELL TRATMAN.

(*Continued from page 74*).

Separate Plate Ties.

Mr. James Livesey first introduced the method of introducing plate ties ("pot sleepers") for supporting railroad tracks, and though little used in Europe, they have met with much favor abroad, especially in India. This favor is principally because these separate ties give good results, the conditions of speed and the weight of the trains being very different in the colonies to what they are in Europe; and they offer this advantage, for transport from England to India, that two of these ties weigh less than one cross tie. In the first designs Mr. Livesey placed the rail directly on the support, afterwards he deemed it preferable to substitute a more elastic track, and therefore interposed a bearing piece of wood or rubber, or springs; the difficulty of maintenance owing to this elasticity soon caused him to abandon these additions and to return to a slightly modified form of the original type.

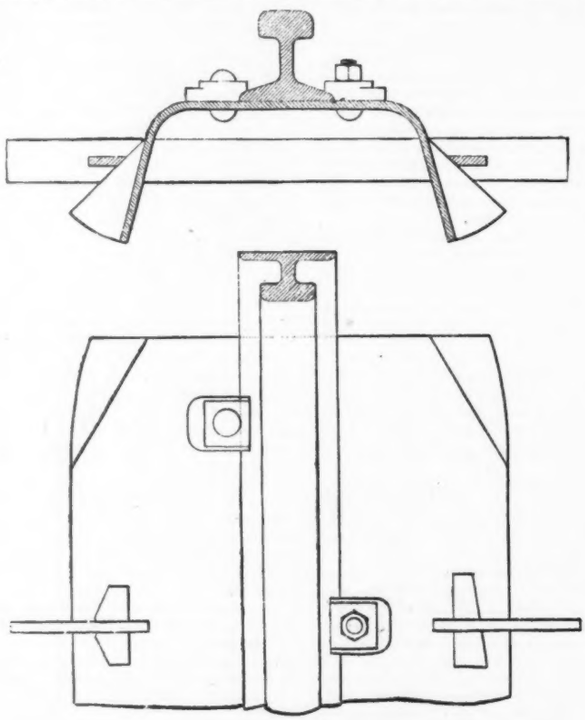


Fig. 18.—Livesey.

The Livesey supports are now made of sheet steel. A cheek riveted to the support serves to receive the flange of the rail, the other side of the flange is held in place by a clamp tightened by a bolt; the loose pieces are thus reduced to a minimum.

For certain railroads in India (such as the Oude & Rohilkund R. R.) which have the broad or "Indian" gauge of 5.5 feet there is an advantage in adopting these supports, owing to the economy in the mass of metal. But without having all the advantages of cross ties, they have several of the drawbacks which have been pointed out in the longitudinals. At discussions at the Institution of Civil Engineers (London), where the question has been often and seriously considered, the majority of engineers who have laid or maintained tracks on these supports have given their opinion that they would not be satisfactory for the heavy traffic and high speeds of trains on the continent.

Fig. 18 represents the form of Livesey rail support adopted for the Egyptian railroads, and Fig. 19 represents a later type adopted on the Great Eastern R. R. (England).

Cross Ties.

Early Trials.—The first trial of metal cross ties was made by M. Le Crenier in 1860; he adopted a tie 7.87 feet long by .82-foot wide, of U section, and weighing 51.7 pounds. The rails, of T section, were attached by means of bolted clamps. The majority of the various forms of cross ties are derivations from the U and Z sections, and this is as it should be, since these forms, placed flat, are those which, with equal weight, give the greatest moments of inertia. In 1862, the Couillet iron-works in Belgium, made a similar trial; the ties were

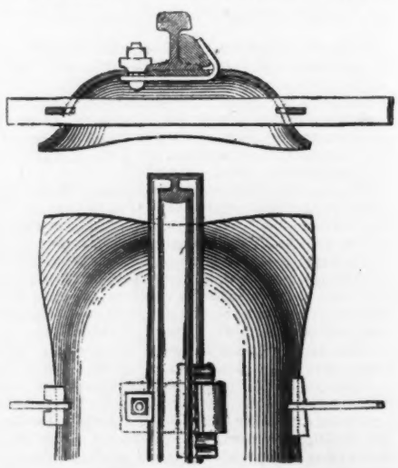


Fig. 19.—Livesey.

heavier, weighing about 100 pounds, and bearing-plates of wood, were interposed under the flange of the rail. Experiments were made in Belgium, France, Spain and Portugal, but without material success. These two forms were applicable only to the Vignoles (T) rail, but about the same time an experiment with a tie for the double-headed (I) rail was made by the Rev. Osborne Reynold; to secure the chair he proposed to cast it on the tie, making openings in the latter to allow the cast-iron to flow behind the upper table; the manufacture of this type, however, presented many difficulties and it was abandoned.

Le Grand. (Figs. 20, 21).—In 1863, M. LeGrand used a rolled tie of trough section, on which

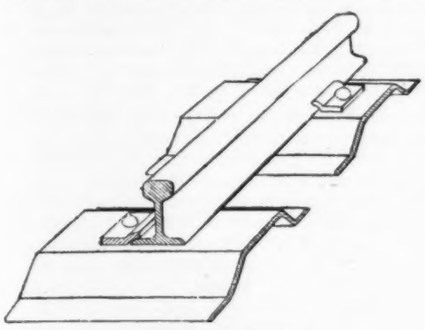


Fig. 20.—Legrand.

were riveted two clamps, at certain distances; he employed two types of tie, on one the clamps were placed so as to grasp the inside edges of the flanges of both lines of rails, on the other the clamps grasped the outside edges of the flange. To lay the track, the rails were placed on ties with the outside clamps, then between each pair of these ties was introduced one with the inside clamps, and by a heavy blow upon one end of the tie it was got into position. This simple system has been employed especially for mine tracks and for street railroads. For main lines it has a great disadvantage, from the reason that it is necessary to displace two lines of rails in order to replace one damaged rail.

Vautherin.—(Figs. 22 to 30).—In 1864 M. Vautherin invented the tie generally known by his name, which has served as a starting

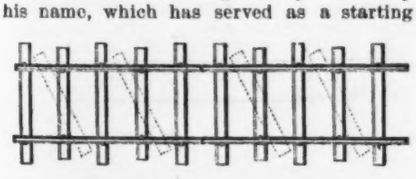


Fig. 21.—Laying Legrand Ties.

point for several inventors. The first trials on the Northern R. R. and Paris, Lyons & Mediterranean R. R. systems have not given very satisfactory results; but the Vautherin tie, a little modified, is now in service on the railroads of Alsace-Lorraine, on the Main-Necker system, where they are known as the Rhenish type, on Dutch and Belgian lines, and on the Algerian system of the Paris, Lyons & Mediterranean R. R.

On the Alsace-Lorraine lines (Figs. 22,23) the tie is of the inverted trough section with the sides strengthened at their edges. These strengthening ribs are to facilitate the placing of the tie in the ballast and to oppose sufficient resistance and solidity to blows. The rail is merely placed on the tie, and is secured by two cramps tightened against the flange by bolts. To ensure the proper cant of 1 in 20 for the rail, the tie is bent on a template to a radius of 3,280 feet. The joints are made by splice bars and bolts in the ordinary manner.

On the Main-Necker lines (Figs. 24,25,26), the type, called the Rhenish, is only the original Vautherin type. Instead of being thickened, the sides of the tie have horizontal portions forming lower flanges; by this means the moment of inertia of the tie is increased, but it is an impediment in placing the tie in the ballast and an inconvenience in ballasting. The rail rests directly on the tie and is fixed by clamps and bolts; the inclination is obtained by what is known by the Hösch Lichthammer method, which consists in inclining a portion of the upper table of the tie so as to have a bearing inclined 1 in 20 under the flange of the rail. Fig. 27 represents the type adopted since 1867.

In 1867 the early form of Vautherin tie was experimented with on the line from Algiers to Oran, which forms a part of the Algerian system of the P. L. & M. R. R. (Fig. 28.) The ties were 7.87 feet long, .85-foot wide at the base, and .33-foot in height; the width of the upper table is .42-foot for joint ties and .26 for intermediates; the thickness of the upper table is .28-inch. The rail is of T section, of the standard type of the P. L. & M. R. R. and is fastened to the tie by the original method—by gibs and cotters; the inclination is obtained by a wedge shaped bearing-plate placed between the rail and tie. The ties are spaced 3.28 feet and weigh about 77 pounds. The following are the data on maintenance, as furnished by M. Mazières, engineer of track, for an average of 100,000 ties laid for 17 years: the total replacement during that period has been 3½ per cent., but one in ten of the wooden ties are replaced each year, while only three in a thousand of the metal ties were replaced of those in use for 17 years. On account of this difference in durability the metal cross ties have, in their 15th year, compensated for the difference in first cost, the remainder of their life is then a clear profit for maintenance. In view of their state of preservation, M. Maziéres states that those on the line from Algiers to Oran, will certainly last for 30 years of service. The causes for replacement are: cracks in the upper part, at the angles, or running from the end of the tie to the rail seat; these cracks may be attributed to inferior metal or to bad ballasting. The metal cross ties have given satisfaction during this experiment of 17 to 18 years.

The Vautherin cross ties were used on the Northern R. R. in 1867, some 5,000 ties being used; the trials proved unfavorable to the system. In 1881 M. Boucher disparaged the tie on account of too numerous parts and insufficient anchorage in the ballast.

The engineers of the Dutch railroads place a wedged shaped plate under the flange of the rail to give the necessary cant (Fig. 29), the rail and plate being held together and fastened to the tie by cramps and bolts.

On the Wurtemberg railroads the engineers have profited by the experience with the Vautherin tie on the Alsace-Lorraine railroads, and the type adopted by them (Fig. 30) resembles the Vautherin tie in the shape of the sides and in the strengthening of the edges, and resembles the Berg & Marche tie in the strengthening of the upper table and the mode of attachment.

Berg and Marche. (Figs. 31, 32, 33).—This type, which takes its name from the railroad first adopting it, is in use in Prussia on the Elberfeld lines, in Germany, on the Louis of Hesse and Grand Duchy of Baden railroads, on the Western of Switzerland R. R., the Northeastern of Switzerland R. R., the Simplon R. R. and the St. Gothard R. R. It is derived from the Vautherin type and is itself the basis of the Post type. The following notes are furnished by M. Jungbecker, engineer of maintenance of way of the Berg & Marche R. R. In 1867, 664 ties were laid on a ballast of well drained sand, they were 7.2 feet long, weighed 62.7 pounds and were spaced at 2 feet intervals; the rails were attached by gibs and cotters. During the first three years, the track was good, the riding easy and the maintenance was about as easy and cost about the same as an ordinary track; but after that time the holes in the ties for the rail attachments became enlarged, cracks occurred and the experiment was abandoned. In 1874 a more important experiment was made in the Ruhr valley; 25,000 ties, similar to the preceding, but stronger, were laid in a ballast composed of flint, mixed with clay, on a steep grade and on a curve of 1,312 feet radius. From the first year, in spite of the care given to the making of the attachments, enlargements of the holes were experienced. The original ties were similar in form to the Vautherin type, an observation on the behavior of the ballast contained in the tie led the engineers to the adopted section; the original ties, too, being open at the ends, the advantage of closing the ends was made evident. Now, thanks to the introduction of mild steel, the trouble with the enlarged holes is avoided and the fastenings are secure. The tie in use on the Elberfeld, Louis of Hesse and Grand Duchy of Baden lines consists of a Vautherin tie the sides of which have been turned down vertically for a third of their length. Only the modes of attachment differ on these lines. In Prussia the rail is fastened by gibs let into openings in the upper table of the tie and secured by cotters. This is the original Berg & Marche attachment, it is simple and inexpensive but is not very stable, yields too easily under the repeated vibration caused by the passage of trains, and requires constant supervision. On the Louis of Hesse lines (Fig. 33) the rail is secured by clamps which are tightened against the flange by bolts; the same method is in use on the lines of the Grand Duchy of Baden, but while in the former case the gauge may be widened or narrowed by eccentric shoulders on the bolts, in the latter a special form of plate is used to effect the same purpose.

The form of the Berg & Marche type, while presenting a less moment of inertia than the Vautherin type, has the great advantage that owing to the vertical sides it can be more easily and more uniformly bedded in the ballast. In all these systems the proper inclination of the rail is obtained either by curving the tie at the center or by slightly bending the ends.

Menans. (Fig. 34.)—Half a mile of track between Byans and Torpes, on the Paris, Lyons & Mediterranean R. R., was laid with these ties from 1864 to 1872.

Paris, Lyons & Mediterranean R. R.—The type "A" (Fig. 35, 36) was in use from 1867 to 1869 between Maisons-Alfort and Villeneuve St. George and between Malains and Velars, but the results were far from satisfactory; the fastenings worked loose, the ties cracked in the angle at the right of the rivets which fasten the chair, and the joint ties broke above the angle-iron, shown in the illustration, which was intended to strengthen the tie. The type "B" which differed from the preceding only in the rail fastenings, was tried on the Grasse branch for eight or ten months in 1871-1872, but the results were not satisfactory; the ties were deficient for want of rigidity of the fastenings.

Brunon. (Figs. 37, 38).—This tie was put down on the Paris, Lyons & Mediterranean R. R., between Rive-de-Gier and Lorette, but the experiment did not last long, from August, 1877, to September, 1878, in consequence of numerous fractures which occurred at the rail seat. About a dozen of these ties, however, made of tempered steel, still remain near Paris.

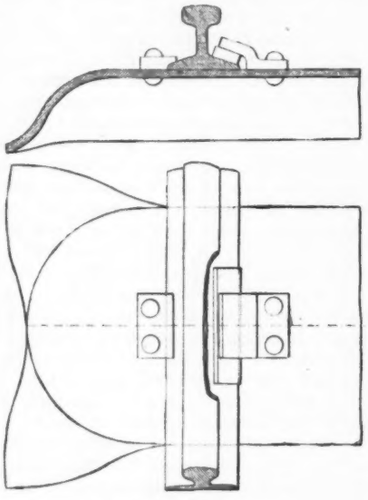
Haarmann. (Figs. 39, 40, 41).—In order of date the Haarmann type comes next, this is in use on lines on both banks of the Rhine and on some lines in Alsace-Lorraine. The section is different from those just described, and is similar to the Haarmann longitudinal (mentioned under the head of "Longitudinals;") it has a sufficient moment of inertia. On both of the Rhine railroads the rail is secured to the tie by bolts and clamps; but the ties differ in the method of giving the cant of 1 in 20 to the rail, on the lines on the right bank the Hösch Lichthammer method is employed, while on the lines on the left bank the ends of the tie are bent. On the Alsace-Lorraine lines the system differs from the preceding in the attachments and in the method of canting the rail (Fig. 41). A wedge plate with an **S**-shaped projection at the end, is placed under the rail, one branch of the **S** clasps the flange of the rail, the other passes through an opening in the tie and has a bearing on the inside of the upper table. A bolt and clamp on the inside of the track forms the only fastening. An objection to the Haarmann type is the difficulty in tamping the ballast in the upper part or hood; the tie rests on its lower portion, and does not take a bearing, as does the Vautherin tie and its derivations, on the upper table. The ballast within the tie plays a secondary part; it is also necessary, in order to secure a satisfactory anchorage in the ballast, to close the ends with plates reaching below the lower flanges.

Wood. (Figs. 42, 43).—Mr. Wood, M. I. C. E., has been influenced especially by the desire to reduce the small, loose material of the track. He has adopted a tie of the Vautherin type, with a smaller rib on the edge, and the rail is secured by a clamp-chair and a wooden key. This clamp-chair has very nearly the form of a horse-shoe, one end presses the flange of the rail against the tie, and the other, acting as a chair, receives the wooden key, which is driven between the steel jaw and the web of the rail. The tie is made of mild steel, and the clamp-chairs of the best steel; the latter are manufactured from steel bars by rolling and stamping, their high degree of elasticity allows them to follow the contraction or expansion of the wood and thus to secure a tight fastening at all temperatures. The ties are bent, like those of the Berg & Marche type, to cant the rail. The Wood ties in service on the Northeastern R. R. (England), are 8.40 feet long and .92-foot wide, with a uniform thickness of .4-inch; the clamp-chairs are 22.8 inches wide and that part of the jaw which grips the flange of the rail is .52-inch thick.

Since these ties have been in use the original rails have been replaced by steel rails, and the clamp-chairs and most of the keys are still in use.

Livesey. (Figs. 44, 45).—Mr. Livesey has adopted for some railroads in the British colonies a cross-tie somewhat similar to his plate tie (described under heading of "Separate Plate Ties"). These ties are made of steel plates with a butting clamp on the outside of the track and a clip on the inside, both riveted to the tie. An iron key, driven between the clip and the flange of the rail, holds the rail tight.

Webb. (Figs. 46, 47).—The tie recently invented by Mr. Francis Webb, M. I. C. E., locomotive superintendent of the London & Northwestern R. R. (England), is one of the very few designed for double-headed rails, and is in use on the L. & N. W. R. R. The cross-section is similar to the Vautherin type with a smaller flange at the bottom. To the upper table is riveted a chair, consisting of three pieces; one serves as a seat or bearing for the lower head, which it partly embraces, the other serves as a lateral support and embraces one side of the lower head and the web, the third forms the jaw for the key which secures the rail. The several pieces of the chair are stamped out with steel dies; the bottom piece is .28-inch thick and the two side pieces are .48-inch thick. To ensure the security of the key a vertical groove is formed in the chair, by which, when the key of compressed wood is driven, a rib is formed on the key and prevents it from working loose. The ties are manufactured at the company's works at Crewe, and are formed by rolling in a three-roll mill an ingot of Bessemer steel, each ingot forming a bar from 60 to 65 feet long. The crop ends of these bars are rolled and stamped while hot to form the several pieces for the chairs. The ties are punched hot in a hydraulic press; the rivet holes being punched together at one stroke so as to ensure their exact relation to each other and accurate fitting in riveting. The parts of the chairs are also punched hot and placed in the mould of the stamping machine, where they are given a finishing stroke. The punches are conical



Figs. 44, 45.—Livesey.

and the holes are so made that the smaller diameters come together, by this means the riveting is tighter and there is less risk of derangement.

The company commenced the trials in May, 1880, and in March, 1885, there were 32,174 ties on a track traversed daily by 24 express trains, some of which attained a speed of 62 miles per hour; the ties have stood very well under this traffic. At first several breakages occurred at the right of the rivet holes, but these accidents were attributed to the fact that Bessemer steel, obtained by the acid process, was used; now Thomas-Gilchrist steel is used, which is better dephosphorized and softer, and no breaks are observed. The weight of a tie complete is given as follows:

	Pounds.
Tie (9 feet long)	123.86
2 chairs	27.94
Rivets	5.06
2 bearing plates	14.96
2 wood keys	1.98
Total	173.80

The weight of the wooden ties in use on this railroad is 242 pounds, including chairs, spikes, etc.

Mr. Webb states that the metal tie completely equipped costs $2.42, of which 12 cents is for labor: while the ordinary wooden tie, fully equipped, costs $2.04; made up as follows:

Tie	$0.98
2 chairs	0.73
Fastenings	0.33
Total	$2.04

(TO BE CONTINUED.)

Municipal Engineering; Paper No. 4.*

PHILADELPHIA, PA.

(*Continued from page 71.*)

Water Department.

The following is a list of the offices and positions in the Water Department with the salaries of each for the year 1886:

Chief engineer, $7,000; general superintendent, $3,500; one assistant engineer, $2,000; one at $1,500, and one at $1,200; one draughtsman $1,800, one at $1,350, one at $1,200, and one at $1,000; chief clerk, $2,000, one assistant $1,080, and one at $900; one other clerk, $1,100, three at $900, and two at $850; messenger, $600; pipe inspector, $1,200; registrar, $3,000; registrar's chief clerk, $1,350; cashier, $1,300; one registrar's clerk, $1,300; two at $1,000, and eight at $900; chief inspector, $950; nineteen inspectors, at $900; messenger $800; one purveyor, $1,600, and five at $1,480; five clerks to purveyors, $939 each; four foremen of repairs, $780 each; three watchmen, $675 each; superintendent of shop, $1,500; clerk to same, $850; janitor, $675; one engineer of pumping station, $1,309, one at $1,100, three at $1,000, four at $950, three at $900, two at $810 each and house, two at $810, and one at $750; twenty-four firemen at $750; twelve coal passers at $675; two oilers at $810, and thirteen at $750; one helper (to engineer) $660; one storekeeper, $800, and three at $750; one watchman, $750, and thirteen at $675; four policemen at $675 and uniform; foreman bricklayer, $950; foreman carpenter, stonemason, rigger and painter each $900; foreman laborer, $675; one telephone operator, $480, and two at $360; and lineman, $720.

Source of Supply.—The chief source of the public water supply is the river Schuylkill which furnished 90 per cent. of the quantity used last year from four stations. The balance is from the Delaware river—two stations—with the exception of a trifling amount of spring water at Chestnut Hill. All the water is pumped at stations within the city—for the most part by steam. At Fairmount station only is water power used—furnished by a navigation dam on the Schuylkill. This station was the first and for a long period the only

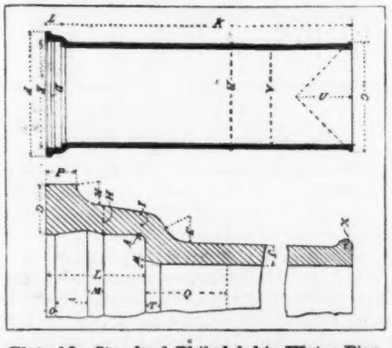


Plate 16.—Standard Philadelphia Water Pipe.

one, but in 1883 its percentage of total pumpage had diminished to about 40, and in 1884 to 33. In 1885, only 17½ per cent. was pumped there, on account of repairs to the turbines. Nearly 45 per cent. was pumped last year at Spring Garden, the principal station, which now has a capacity of about 70,000,000 gallons daily. The average daily pumpage of all the stations in 1885 was 68,945,260 gallons, the maximum 102,191,676, and the minimum 42,177,042.

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Fig. 22.—(Alsace-Lorraine.) Fig. 27.—(Type since 1867.) Fig. 28.—(Algiers.)

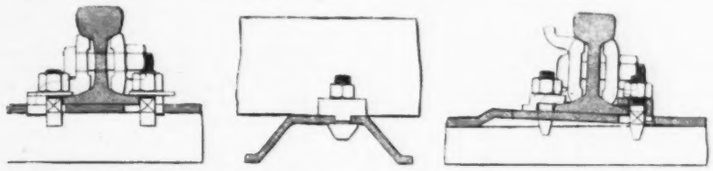


Fig. 23.—(Alsace-Lorraine.) Fig. 25.—(Main-Necker.) Fig. 26.—(Main-Necker.)

Fig. 24.—Vautherin (Main-Necker.)

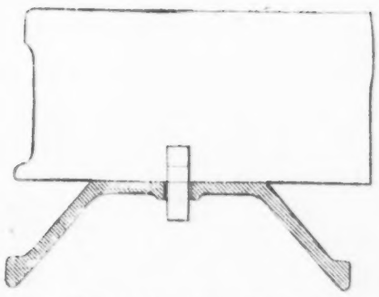


Fig. 30.—Vautherin (Wurtemb erg).

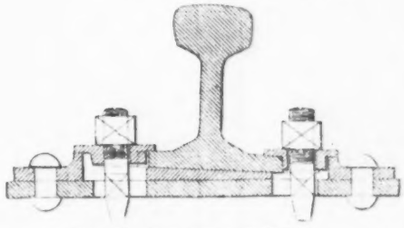
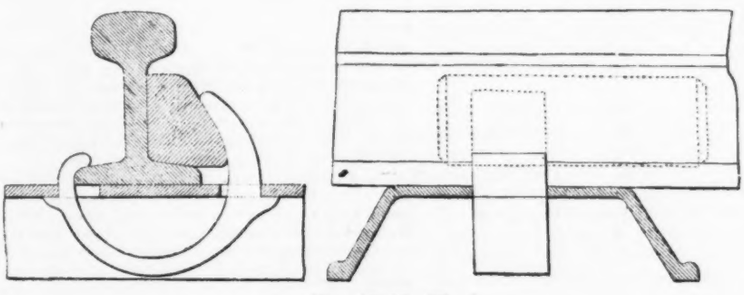


Fig. 29.—Vautherin (Holland).

Fig. 32.—Berg-Marche.

Fig. 31.—Berg-Marche.



Figs. 42, 43.—Wood.

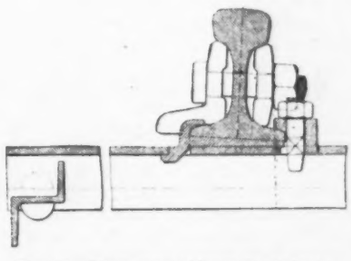
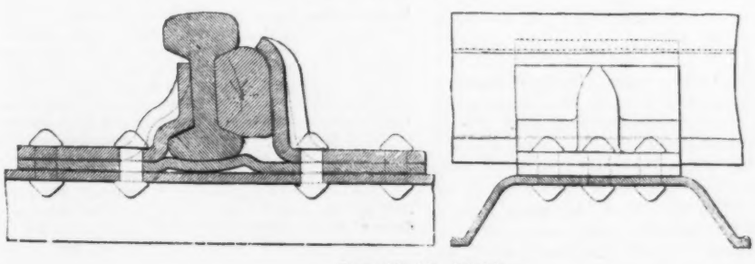


Fig. 41.—Haarmann (Alsace-Lorraine).



Figs. 46, 47.—Webb.

Fig. 38.—Brunon.

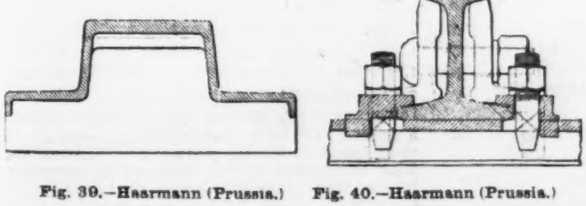


Fig. 39.—Haarmann (Prussia.)

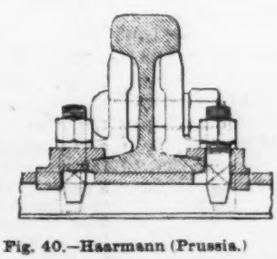


Fig. 40.—Haarmann (Prussia.)

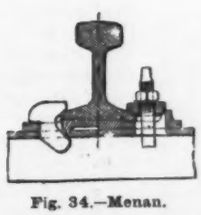


Fig. 34.—Menan.

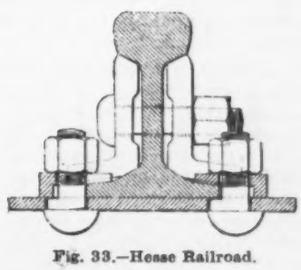
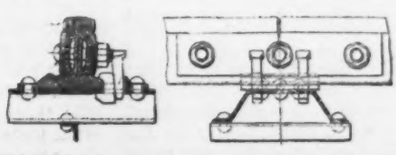


Fig. 33.—Hesse Railroad.

Fig. 37.—Brunon.



Figs. 35, 36.—Paris, Lyons & Mediterranean R. R.

Philadelphia Water Department. Straight Pipe References.—(See Fig. 16.)

Size.	4	6	8	10	12	16	18	20		30			36			48			
Thickness.	3/8	7/16	7/16	1/2	9/16	5/8	5/8	5/8	11/16	11/16	11/16	1	11/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16
A	4	6	8	10	12	16	18	20 1/2	20	30 1/2	30 1/2	30	36	35 3/8	35 1/2	47 3/8	47 1/2	47 1/2	47
B	4 3/4	6 7/8	8 7/8	11	13 1/2	17 1/4	19 1/2	21 3/8	21 3/8	32	32	32	37 1/2	37 1/2	37 1/2	50	50	50	50
C	5 1/8	7 1/4	9 1/4	11 1/2	13 5/8	17 3/4	19 3/4	21 3/8	21 3/8	32 1/2	32 1/2	32 1/2	38 1/2	38 1/2	38 1/2	50 3/4	50 3/4	50 3/4	50 3/4
D	5 1/2	7 3/4	9 3/4	11 7/8	14 1/2	18 1/4	20 1/4	22 3/4	22 3/4	33 1/4	33 1/4	33 1/4	39 1/2	39 1/2	39 1/2	51 1/2	51 1/2	51 1/2	51 1/2
E	5 3/4	7 1/2	9 1/2	11 7/8	13 7/8	18	20	22 1/2	22 1/2	32 7/8	32 7/8	32 7/8	38 7/8	38 7/8	38 7/8	51	51	51	51
F	7 1/8	10 1/4	12 1/4	14 5/8	17 1/2	21 5/8	23 3/4	26 1/2	26 1/2	38 1/2	38 1/2	38 1/2	44 1/2	44 1/2	44 1/2	58	58	58	58
G	1 1/4	1 1/2	1 3/4	1 7/8	1 7/8	1 11/16	1 7/8	2	2	2 5/8	2 5/8	2 5/8	2 7/8	2 7/8	2 7/8	3 1/2	3 1/2	3 1/2	3 1/2
H	3/4	3/4	7/8	7/8	11/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/4	1 1/4	1 1/4	2 1/2	2 1/2	2 1/2	2 1/2
I	3/4	3/4	11/16	11/16	7/8	11/16	1	1	1	1 1/16	1 1/16	1 1/16	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2
J	3/8	7/16	7/16	1/2	9/16	5/8	5/8	5/8	11/16	11/16	11/16	1	11/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16
K	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'
L	3	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	4 1/2	4 1/2	5	5	5	5	5	5	5
M	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
N	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
O	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	7/16	7/16	7/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4
P	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/4	1 1/4	1 1/4	2	2	2	2
Q	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	4 3/4	4 3/4	4 3/4	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2
R	1/4	7/16	7/16	1/2	11/16	11/16	3/4	3/4	3/4	1 1/2	1 1/2	1 1/2	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
S	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/4	1 1/4	2	2	2	2 1/4	2 1/4	2 1/4	2 1/2	2 1/2	2 1/2	2 1/2
T	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4
U	2	3	4	5	6	8	9	10	10	15	15	15	18	18	18	24	24	24	24
V	7/16	7/16	7/16	7/16	1/2	1/2	1/2	1/2	1/2	5-16	5-16	5-16	1/2	1/2	1/2	1/2	1/2	1/2	1/2
W	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	3-16	3-16	3-16	3 16	3-16	3-16	3-16
X	3-16	3-16	3-16	3-16	1/4	1/4	1/4	1/4	1/4	5-16	5-16	5-16	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Est'd. Wei'ht	216	360	480	660	900	1320	1464	1680	1800	3240	3720	3960	4560	5040	5520	7200	7800	8520	9240

The water supplied from all but one of the stations is more or less polluted by the sewerage of the city. The Roxborough station (supplying Manayunk and Germantown, as well as Roxborough) is above the reach of the city pollution but is fouled by the drainage of numerous towns above. The need of a new supply has long been agitated and very extensive surveys have been made in the last three years during the administration of Col. William Ludlow, under the immediate direction of Rudolph Hering, engineer in charge, but no action seems likely to be taken under the present management toward carrying out either of the schemes that have been elaborated. Both look to an extensive tract on the eastern border of the state about a hundred miles north of the city (by the conduit routes), eminently fitted for a perpetual supply of great purity. In one case the Delaware and a small tributary about 35 miles from the city would furnish a temporary supply until the conduit should be extended to the upper Delaware; and in the other the stored waters of the Perkiomen (principal tributary of the Schuylkill) would be taken on the way to the upper Lehigh.

Reservoir and Distribution.—The distribution is chiefly from small open basins in earth embankment, though a large and rapidly growing district is supplied by direct distribution, in the absence of a basin at a sufficient elevation. The total reservoir capacity at present is only about 190,000,000 gallons or less than three days' average requirements. Two large basins are proposed, to have a combined capacity of nearly 1,000,000,000 gallons, and one—the East Park—was half completed several years ago.

Distribution pipes have for the most part been laid with little attention to grade—following the street surface, 4½ feet underground for pipes under 12-inch, and 3 feet under for large sizes, 18 inches being the minimum depth (to top of pipe.)

The standard form of bell and spigot, with dimensions, is shown in the accompanying sections and table, (Plate 16).

The tools used in laying and caulking pipe are much like those already described as used in Boston and Providence. No rule is observed as to the quantity of lead in joints; they are usually filled to a depth of 1¼ inches in pipes of 12 inches diameter and under, and 1½ inches in larger sizes. The joints are never entirely filled except in situations subjecting them to severe shocks or jars—as pumping mains near the pumps and under railroad tracks.

The work of laying water pipes and making repairs to the same is done by the Department (by days' labor) under the immediate direction of six superintendents, styled Purveyors.

Water Pipe Assessments.—"Whenever any pipes for the conveyance of water shall be laid in any of the streets or highways within the City of Philadelphia, the owners of the ground in front whereof the same shall be laid, shall pay for the expense thereof, the sum of one dollar for each foot of their ground upon such street: *Provided*, that on all corner lots an allowance shall be made of one-third the length of one of their fronts, but such allowance shall be always and only on the street or highway running at an angle to the street or highway in which pipe shall have been previously laid and paid for; but in no case shall the allowance exceed 50 feet on any corner lot." This assessment is known as "Frontage."

(TO BE CONTINUED.)

CAMDEN, N. J., is to pave a block of one of its principal streets with the new fire-brick paving which has recently sprung into favor in the West, and been extensively adopted in Steubenville, O., and Wheeling, W. Va. It will be laid at the instance and expense of property owners along the square, and the result of the experiment will be watched with interest.

PUBLICATIONS RECEIVED.

Annales des Ponts et Chaussées, Oct. and Nov. 1886. The October number contains a very detailed and full description of the bridges of Castelet, De Lavaur and Antoinette. These are stone arch bridges of about 137,205 and 166 feet span respectively; the paper describes and illustrates the construction, centering, and the theoretical reasons for the curves adopted. The November number contains illustrated papers upon an automatic regulator for the speed of trains; derricks for handling lock-gates; an interesting illustrated paper upon the renewal of the anchorage cables of the St. Christophe suspension bridge over the Scorff, and a report upon the Belgian regulations for the use and care of steam engines.

Institution of Civil Engineers. "Concrete as applied to the construction of Harbors."—A very complete series of papers and discussions on concrete work; illustrated. "Electric Light-houses of Macquarie and Tino:" Full description of new light-houses in Sydney and Italy; discusses the dynamos, horse-power, etc.

Hand Book of Virginia. Fifth edition, issued by the Commissioner of Agriculture, Richmond, Va. With fine State maps; gives population, areas, valuation, industries and mineral and agricultural resources of the towns, counties, etc., of Virginia. A good exhibit of the Virginia of to-day.

Maps No. 8 (Trenton), No. 11 (Camden) and No. 12 (Mount Holley) of the Geological Survey of New Jersey, are now issued by Mr. Geo. A. Cook, State Geologists. Only four of the seventeen sheets required to complete the series remain to be issued, and these four are promised for 1888. The new maps are of the same general character of excellence that has gained for their predecessors the repute of being the finest State maps ever published in this country.

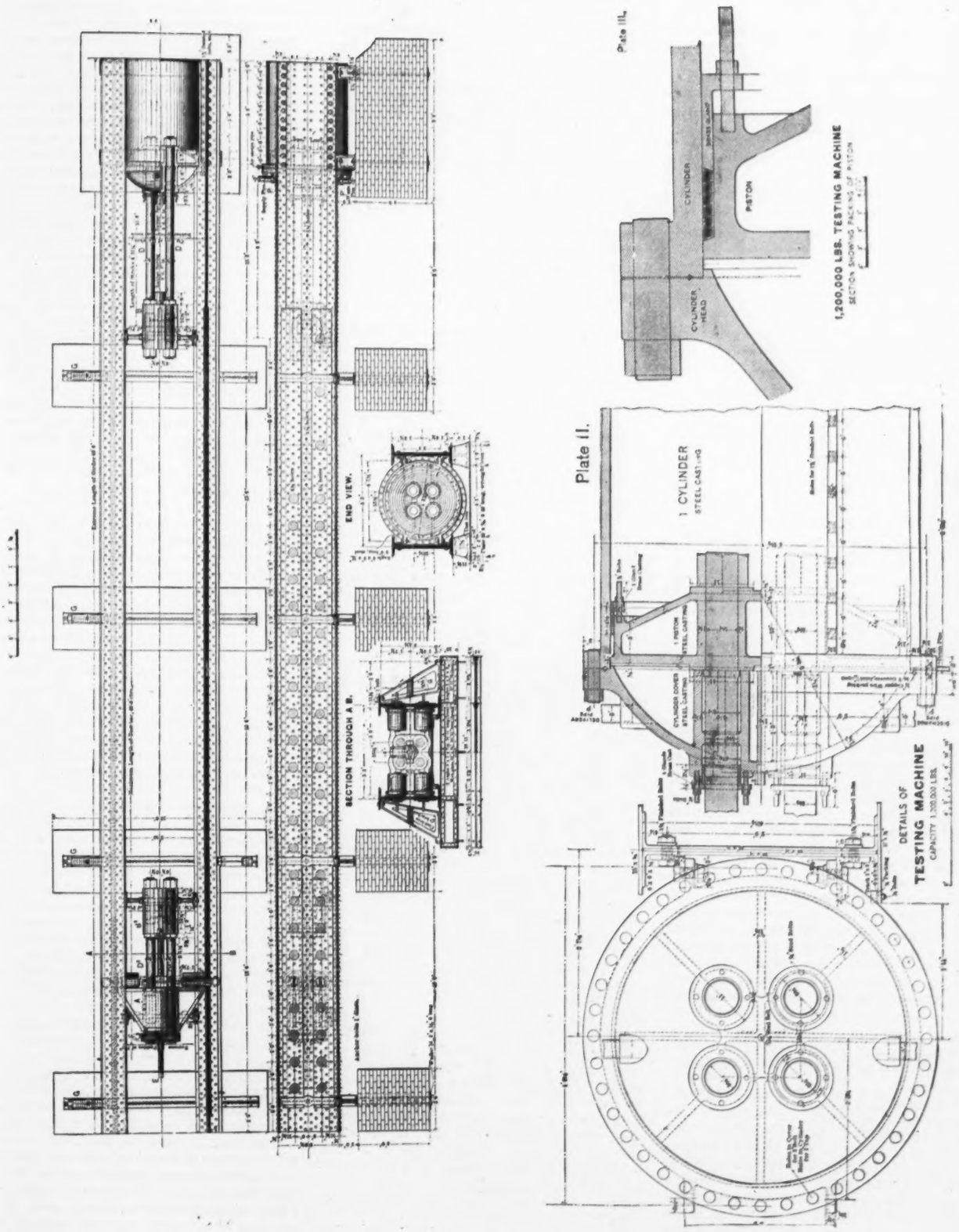
The Pump Catechism: a Practical Help to the Runners Owners and Makers of Pumps of any kind. Covering the Theory and Practice of Designing, Constructing, Erecting, Connecting and Adjusting. By ROBERT GRIMSHAW, M. E., etc., etc. Profusely illustrated. Practical Publishing Co. New York, 1887. Size: 4x5¾-inches; p. 233. Price, $1.00, post paid.

The very decided success of the author's "Steam Engine" and "Boiler" Catechisms is a sufficient warrant for the appearance of the present volume; and it is almost sufficient endorsement of it to say that the same admirable system of practical questions and answers, that have made its predecessors popular and useful, is carried out in the "Pump Catechism." Mr. Grimshaw commences with general definitions, and the general principle of action in all kinds of pumps; he then describes the types of valves, and the general principles of design, construction, erection, connections, piping, care and use. This introductory, as it may be called, is profusely and admirably illustrated.

The author then illustrates in detail, and describes all the popular pumps now in use of special manufacture, some nineteen in all; he points out their peculiarities of design, and dwells on their management and use. The Catechism concludes with a very well selected series of tables and formulæ useful to the man who has to do with pumps. From personal examination we can heartily recommend it to the class addressed, as a practical and useful volume, unique in its form, and as a something that has been long wanted.

The Earth Temperatures at Lake Superior Mines.

H. A. Wheeler, in the *American Journal of Science*, 1886, p. 125, records some interesting observations on the increase in the earth's temperature. The copper mines of Keweenaw, on Lake Superior, are now among the deepest in this country. The author notes that usually a decent of 50 to 55 feet vertical is equivalent to an increase of temperature of 1° Fahrenheit, with exceptions to this rule. At the Superior mines the average gradient is about 100 feet to the degree. This is exceptionally low, but the variations among the different mines is very striking, ranging from 76.5 feet to 122 feet per degree. The rock in the mine gives no explanation, as the widest divergance is in rock of the same character. The proximity to the lake seems to offer the true solution of the puzzle, as the mines nearest the shore have the lowest gradients. All of the mines are near the lake with its water at 38.8 F., and the Osceola mine, 5 miles away, shows the highest gradient of 76.5 feet.



600-ton Testing Machine—Union Bridge Company. Designed by CHARLES KELLOGG, C. E. See page 97.

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

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D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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THERE seems to be at least a possibility that the Inter-State Commerce bill may not become a law after all, but that there is a field of usefulness for some such law to improve the relations of the railways with each other as well as with the public is amusingly illustrated by an incident made public this week.

There is a great bridge across the Mississippi river at Dubuque, built by a separate company under authority of Congress and the State of Illinois, with certain conditions forbidding discrimination. What does the bridge company do, however, if the published accounts are correct, but build all the great structure but one short span, and leave that to be built and owned by the Illinois Central, which is now alleged to be attempting to use it in a sort of portcullis fashion, to keep another company from reaching the main bridge, which it would otherwise have a right to pass over.

We have not the slightest idea that the Illinois Central meant more in this move than simply to protect itself against its rivals to the full extent of its rights and to have at least possession in its favor, but the absurdity of such an attempt to evade the plain purpose of the law would have been very conspicuous had a private individual attempted to put a few planks at the end of some road bridge authorized by law, and attempted to forbid passage.

THE biggest progress on record for a tunnel heading, we believe, has just been made in the new aqueduct tunnel at shaft No. 5, on the O'Brien & Clarke contract; viz., 612 feet on two headings during the month of January, which was done in twenty-six working days. The progress on one heading was a little under 300 feet, and on the other considerably over 300 feet, amounting to over 12 feet per working day in one heading, and nearly 12 feet in the other. The greatest progress heretofore recorded has been 277 feet per month on one heading.

The heading is a very large one, 8x16 feet, semi-circular, running about 3½ cubic yards per foot, or about half the total section of the tunnel. The rock is solid gneiss, with very few seams. Rand "slugger" drills were used, three in one heading, and two in the other.

During the last week, ending Saturday, January 29th, 90 feet was made in the south heading by twelve shifts. The greatest progress made in the remarkable work on the South Pennsylvania was 84 feet, at the Allegheny tunnel. On the Sutro tunnel, where also some very remarkable work was done, the highest record was 10.3 lineal feet per day.

MR. C. P. SANDBERG has long been advocating a heavier rail section on Continental railways as demanded by the growing dimensions of traffic and a true regard for economy of service and increased speed of traveling. His views are now finding acceptance in Belgium, and the *Societé Cockerill* is rolling rails of the Sandberg section which will weigh 101 pounds per yard. These rails will be laid on certain roads over which it is designed to run trains at greater speed than hitherto.

Though the tendency in this country is decidedly towards an increase in weight, these "Goliath" rails exceed any output of our own mills. The Manhattan Elevated Railway is laying an 80 pound rail with the Fisher joint, now the standard on that road, and some 90 pound rails are being made as an experiment by one of our great trunk lines.

IT is now stated positively that work on an elevated railway on State street, in Chicago, will begin next May, Jas. G. Smith, of New York, being President of the Company. If so, it will be the first elevated railway to be constructed outside of New York, except the one in Brooklyn. It is a practical certainty however, that there will be a considerable mileage of such lines constructed in Boston in the near future, and it can hardly be but that ere long the construction of such lines will be greatly multiplied, The brilliant success of the New York lines has stimulated the construction of considerable elevated mileage in Europe, but so far has been without its usual effect in this country. Such structures as that which the Pennsylvania Railroad is about to erect in Jersey City, although elevated railways in a physical sense, are not referred to above, since they are not built for local use, but that structure also enjoys the distinction of being the first of exactly its kind in this country, viz.: lines built purely to facilitate quicker and safer transit through city limits, and not to reach some otherwise inaccessible point, like the extensive works for entering New York, Philadelphia and St. Louis, or to improve the grades at the same time, as at Rochester. It also is doubtless only the precursor of a long list of similar works in all our large cities. It is all but certain that vast sums will be expended on similar works in the next twenty years, as there has been in England in the past twenty.

IT was objected to the 24 o'clock system, at the late annual meeting of the American Society of Civil Engineers, that the striking of clocks would be a somewhat difficult matter to regulate, since it would be rather wearing to count up 23 or 24 o'clock, struck in the usual manner. There is, however, a very easy remedy for this difficulty, the efficiency of which has been tested on a very large scale in the striking of fire-bells and in other ways, but which, singularly enough, was not suggested either in the discussion or in the voluminous documents accompanying the report.

This remedy is to strike up to 10 or perhaps 11 in the usual manner, but to represent 12 by - --, 13 by - ---, and so on up to 20, which is represented by --, the same as 2; 21 being -- -, 22, -- --, and so on. This does not necessarily involve the use of more than one bell, and by trying the effect on a bell or by rapping with the knuckles, it will be seen that the effect is perfectly distinctive, and the ear readily recognizes what is meant, almost without instruction.

The only other alternative suggested, to strike up to 12 and then repeat, would be destructive of the very end sought, since it would perpetuate the double series of numbers.

Rather than that, it would be better to strike up to 10 and then repeat, for which something might be said. If a clock struck --- for example, there could hardly be difficulty in knowing at once whether it meant 3 A. M. or "13" or "23" o'clock without perceptible mental effort.

There does not as yet seem to be any alarming probability that this question will soon become a practical one, but it is a pity that imaginary difficulties should stand in the way of what would no doubt be a desirable reform if it were once fairly introduced.

THE great pneumatic caisson for the Harlem River bridge, 54 by 104 feet, outside measurement, and one of the largest in the country apart from the great Brooklyn bridge caisson (which was 168×102 feet) is making satisfactory progress. It has struck rock on one edge, 17 feet down, the rock at the other edge being 42 feet down. For the first time in the history of pneumatic foundations "steam" drills worked by compressed air are now at work. Boulders cause more annoyance than the solid rock but the caisson bids fair to be down to place by April 1. Dynamite is used exclusively for blasting. The material is removed exclusively through air-locks, four buckets, holding one quarter yard each, passing through the lock at once.

This caisson was built in place, a sheet pile coffer dam being built around the site, filled in with silt from the bed of the river. Although apparently on solid dry foundation it was found to have moved toward the river from 12 to 18 inches when completed. Although the mass weighed nearly 1,100 tons it was moved backward through that distance, and about as much more, by anchoring heavy chains to "dead men" placed on shore, and using jacks, before commencing sinking; and it has since not moved at all, during the process of sinking, so that it is now nearly as much out as before, but in the other direction, which leaves no room for anxiety as to further movement.

THE first serious work on the foundations of the new Hawkesbury bridge, for which Anderson & Barr have the contract, began early in October. On January 1, 1887, one pier was down 12 feet in the solid, with 25 feet of concrete in it and 50 feet of the iron shell in place, and another caisson nearly ready for launching. Progress has been somewhat impeded by the usual transportation and other delays so common with new works of magnitude at remote localities.

SIR LOWTHIAN BELL, in discussing the future of English ironmasters as likely to be effected by the wonderful natural resources and rapid advance in the iron industry of this country,

figures out to the satisfaction of himself and Britons generally that we can never successfully compete with England in foreign markets, other than Canada and South America.

He admits our advantages in a vast supply of raw material of the finest quality; but thinks we will always be handicapped by the widely scattered nature of these deposits and the cost of transportation of the ore to the fuel, or the contrary. He believes that the new Southern fields are destined to be the cheapest iron producing center in the United States, but that its distance from tide-water will always be against it as an exporter to foreign parts.

We fear that Sir Lowthian Bell does not realize that our present rates of transportation are so low, as compared with the English, that we can carry the class of goods referred to for about one-fifth of the average rate prevailing in England. Relative distance from the sea-board must be discounted proportionately; and, moreover, we have been steadily reducing our rates, while those of England have remained stationary for over two decades. We may do better yet.

ONE of the unfailing evidences of good times is a large volume of immigation. The quarterly report just issued for the quarter ending September 30, 1886, shows a total of 105,702 against 82,147 a year ago, an increase of 28 per cent. Of male immigrants only the increase is per cent. against only, 17 per cent. of woman. This is one of the minor evidences that good times are just beginning. The usual rule is that in the beginning of periods of prosperity the proportion of men rises, owing to the demand for labor, but as the culminating point is approached and passed the proportion of women rises, owing to there being more money to send back to bring them over and a less rapid expansion of the demand for labor.

THE Prussian Government offers to buy eight more private railways for $36,850,000, the total construction of which amounted to $48,400,000. The State offers 3½ per cent. consols to the amount of $850,000 annually, whereas the total dividend declared on these roads in 1885 was $845,000. As the German roads are dependent on the Government for rates of tariff they will hardly refuse the offer.

THE bridge over the East river at Blackwell's Island is again engaging public attention as the House Committee on Commerce has recommended the revised House bill authorizing its construction. This new bill contemplates a railway bridge, with provisions for foot passengers, with a clear height of 142 feet above mean high water. It must be commenced within three years. It is an important project, but as yet in a somewhat indefinite stage as to actual progress.

AN experiment shedding some light on the old college problem, which most of us can remember, of what would happen to impenetrable bodies if they came together with irresistible force was tried last week on the Perkiomen road. Some thieves were carrying off a heavy safe, with $50,000 in it, on a lorry, with sundry bars and sledges, when it was struck by a fast freight locomotive, running probably 20 to 25 miles an hour. Result: The locomotive was not hurt; the safe was not hurt, but thrown into the ditch, and the lorry broken to fragments. All of which beyond doubt, resulted from the simple fact that the pilot had a fair chance to get its nose under the obstruction, before the serious business began. The obvious moral of this certainly extraordinary incident,—that if the nose of the pilot extended down below the level of the rails almost any obstruction which could be placed upon the rails would be likely to be removed—does not seem to have any very practical bearing, because of the certain difficulties in respect to turnouts and crossings, but may be worth a moments' reflection.

THE *Manchester Guardian* (England) in commenting on the forthcomg American Exhibition in London remarks that the Americans, having excluded all English imports, are now proposing to push their own exports by the exhibition on British soil of American-made goods. The *Guardian* concludes that we think that as "Americans may not buy English manufactures, *ergo*, on Christian principles, Englishmen ought to buy American manufactures". To which we answer, certainly they should, if the purchaser gets for his money a better-made and more serviceable article, be it a locomotive or a garden hoe.

Chicago Drainage and Water Supply Commission.

The Drainage and Water Supply Commission of Chicago, through Chief Engineer Rudolph Hering and Consulting Engineers Benezette Williams and Samuel G. Artingstall, made a preliminary report on January 27. This report outlines the character of legislation required to carry out any ultimate project, and gives exhibits of some of the preliminary observations necessary before any scheme can be finally decided upon.

Charts were presented giving the growth of population centers in the United States (see ENGINEERING NEWS, Jan. 15), and another showing the daily fluctuation of the water surface of Lake Michigan to have ranged on one day (Aug. 16, 1886) from 1.5 above zero to nearly 4.5 above the same datum. A third chart exhibits the proportion of sewage in the lake water along the city front; this being from 1 part to 4 in the Illinois and Michigan canal to 1 part in 138 at the Fullerton avenue conduit.

In comparing the projects for disposing of the sewage the Commission concludes that to throw the sewage into the lake from 2,500,000 people and go to Grosse Point for a water supply would cost $37,000,000, with an annual expense for interest and operation of at least $2,000,000, and an immediate outlay of $20,000,000. To dispose of the sewage by filtration on land would cost $58,000,000, with an annual expense of $3,900,000, and an immediate outlay of $34,000,000. For the disposal by the Desplaines river, the estimated cost for the main district is between $20,250,000 and $24,550,000; for the Calumet district it is between $2,850,000 and $3,400,000. The annual cost, including interest and operation, is estimated at about $1,300,000. To carry out this latter project will involve an immediate expenditure of about $5,500,000 for preliminary work, that could be completed in three years, and would greatly lessen the dangers from pollution until the final completion of the Desplaines project.

By discharging the sewage into the Mississippi the water-supply problem is much simplified. The present economical capacity of the two tunnels under the lake is between 90 and 100 millions of gallons daily, or less than the present average consumption. The maximum capacity is about 150 millions per day. The Engineer of the Commission, Mr. Hering, estimates that at the present rate of increase, the maximum demand in 1887, will be 145 millions; in 1888, 155; in 1889, 167, and in 1890, 180 millions of gallons daily. To provide against accident, and an inadequate supply in the near future, a new tunnel is now under construction, with an intake 1,500 feet from shore, and connections with the two main tunnels at the north pumping station. The total pumping capacity of this station is now 67 millions of gallons; but the new pumps being erected will increase this to 91 millions. The total pumping capacity of the West side is 60 millions of gallons.

As the pumps are at times now delivering 120 million gallons per day, very near their maximum capacity, the Commission state that new works are imperatively necessary. They recommend two stations near the business center of the city and south part, as requiring a shorter tunnel, and as being near the center of greatest demand. Other stations will gradually become necessary as the population increases. To provide for a possible population of 2,500,000, at 130 gallons per head, would ultimately require a combined capacity of 325,000,000 gallons per day. They advocate a submerged intake as safer from passing vessels and stoppage by ice; and with the sewage excluded fom the lakes think that at two miles from shore they could obtain a supply free from all suspended earthy matter.

The Engineering Force of the City of New York.

The official list of "the officers and subordinates of the city and county government" of New York is, in the aggregate number and salaries paid, a sufficient index of the vast machinery required for the daily routine work of a great metropolis. To simply count these names is a task too great for our present leisure or inclination. But we can give some idea of that portion which has to do with the actual engineering work, and condense from the voluminous original as follows:

Commencing with the Department of Public Works, we find that General John Newton, the Commissioner, has a salary of $8,000 per annum, and is assisted by a Deputy Commissioner at $5,500, together with some fourteen clerks and messengers. The Chief Engineer of this department is paid $7,000, and is assisted by a Consulting Engineer at $4,000, and by nine Assistant Engineers, at salaries ranging from $3,000 to $1,800; five Levelers, at $1,400 and $1,200; nine Rodmen, at $1,200 and $1,000; four Chainmen, at about $900, and six Draughtsmen, paid from $2,000 to $1,000 per annum. The Water Purveyor ($2,750), has one Transitman at $1,500; and the Engineer-in-Charge of Sewers ($4,000), has four Assistant Engineers, at $2,700 to $2,250 salary; four Rodmen, at $1,500 to $1,200; one Leveler, at $1,200; and four Draughtsmen, at $1,500 to $1,200.

The Department of Public Charities and Correction has at present two Supervising Engineers, at $2,000 and $1,000 salary.

The Department of Public Parks has two Engineers of Construction, at 3,000; one Topographical Engineer, at $3,000; fifteen Assistant Engineers, at from $2,200 to $1,200; seven Draughtsmen, at $1,200, and ten Computors, Chainmen, Axemen, etc., at salaries ranging from $1,200 per annum to $2.50 per day.

The Department of Docks has a Chief Engineer at $6,000 per annum; a First Assistant Engineer, at $3,000, another at $2,000, and five Draughtsmen at $1,320 to $900 per annum.

The Aqueduct Commission, as might be expected, is the chief employer of engineers. The Chief Engineer has a salary of $10,000, and is assisted by one Consulting Engineer, at $5,000; two Principal Assistant Engineers, at $4,800, and a Special Assistant at $5,000. There are five Division Engineers, at $3,000; two Assistant Engineers, at $2,400, and eighteen at $1,800; ten Draughtsmen, $1,500 to $1,200; two

Transitmen, at $1,500; two Levelers, at $1,200; twenty-nine Rodmen, at $900; twenty Chainmen, at $720; and nine Axemen, at $720. While not properly to be classed with the engineering staff, there are three Special Inspectors, at $1,800; and fifty-five Inspectors, at $1,440 each, and this last named list is to be increased by forty more.

There are thus about 170 engineers of all grades in the employ of the City of New York; 72 of these being engaged on the Croton Aqueduct, the inspectors not included in this estimate. In annual salaries paid engineers, the Department of Public Works expends about $97,500, not counting assistance paid for by the day. The Park Department pays out about $40,000 annually in the same manner, and the Dock Department, $15,100. The Aqueduct Commission pays slightly over $148,000 per annum for its engineer corps, to which should be added nearly $80,000 for its staff of inspectors. None of the above estimates include the clerical force demanded by the department works.

Street Cleaning in Paris.

We condense from *Engineering*, of January 14, 1887, an article on the organization of the street cleaning service of Paris.

The Direction of Works in Paris, presided over for many years by M. Alphand, has sole control of all work classified as below, and is divided into the seven following principal divisions:—

1. The public streets, temporary concessions and the construction of sewers.
2. Promenades and plantations; public and private lighting; permanent concessions connected with streets.
3. Water supply and drainage.
4. Purification and control of the Seine; utilization of sewage water; irrigation; the establishment at Gennevilliers.
5. Railways in and around Paris; the Paris cemetery at Marcy-Sur-Oise; control of vehicles, telephones and pneumatic clocks.
6. The consultative engineering department.
7. The vicinal service of the Department of the Seine.

The first divsion, with which this article has to do, is subdivided into two divisions, each headed by an Engineer-in-Chief; the first of these divisions includes all the central *arrondissements*, or wards, and the second, the outer wards, each being again subdivided into three and five sections, respectively, each section under the control of an engineer. The official heads of these divisions and subdivisions are selected from the *Pont et Chaussees* on the nomination of the Minister of Public Works, and while so detailed are subject to all the rules of advancement, etc., of that corps. They are paid by the City of Paris. The sub-engineers and foremen are nominated by the Prefect of the Seine.

In the two great city divisions the public road service and scavenging are combined. The personnel of the first division comprises 95 agents for the public roads and 58 for scavenging; the second, or suburban division has 103 agents for the former and 54 for the latter service. The total staff thus includes 210 agents.

In March, 1873, a law was passed which converted into a municipal tax the former obligation of the citizens to sweep the public areas facing their properties. In fixing the rate of this tax no account was taken of the value of property; the necessities of traffic and the sanitary and proper conditions of the streets alone being considered. But the total tax must not exceed the cost to the city of Paris of sweeping the area for which the citizens would be otherwise responsible. The payment of this tax, however, does not exempt householders from the police obligations during periods of snow and frost.

A regular table of rates, is published giving the tariff per square metre under various conditions of location, ranging from 70 centimes to 4 centimes per square metre. The areas to be swept in Paris are:—5,730,000 square metres for Division 1 and 8,770,000 square metres for Division 2. This amounts to 14,500,000 square metres (or about 155,875,000 square feet) in total; and assuming an average tariff of 38 centimes per square metre, the tax would be 5,510,000 francs, or $1,102,000.

The work of scavenging includes three distinct operations:—

1. Sweeping by the city workmen,
2. Sweeping by mechanical means.
3. Removal of mud, etc., collected.

Hand sweeping is provided for by 122 stations, 52 in the first division and 70 in the second. In the former each station has one director, one foreman and 25 or 30 laborers. The suburban division has one director, four foremen and from 16 to 20 laborers at each station. There are thus in all about 3,000 laborers, male and female, employed under the control of 310 foremen and sub-foremen. In the central division all work is generally completed in the first half of the day, the sub-foremen alone being retained during the afternoon for supplementary work. In the suburban division the whole day's work is concluded at 4 P. M., and the half-day's work at 10 A. M. In summer sweeping is commenced at 3 A. M., and in winter at 4 A. M. The wages paid are 100 to 105 francs ($20 to $21) per month for the first and second class employés and 80 to 85 francs ($16 to $17) to the common workmen. Supernumeries are paid at the rate 20 to 35 cents per half-day according as they are lads, men or women.

Mechanical sweeping effects an economy of two-fifths as compared with hand sweeping. In comparative experiments covering twenty-two miles of streets, the following results were obtained;—for this length a force of sixty men, divided into five brigades, was required for hand work, and the cost was 135 francs, or say $1.23 per mile. For the sweeping machines the return stood as follows:—

	FRANCS.
4 Horses at 6 francs	24
4 Drivers at 3 francs	12
12 Sweepers	24
Wear of brooms	14
Maintenance	8
Total cost	82

or about 75 cents per mile. The "Blot" sweeper used weighs about 1,700 pounds, and is hauled by one horse. At ordinary speed it can sweep over 6,000 square yards per hour, equivalent to the work of 10 or 12 men; their price is $200 and the annual renewal costs about $40, not counting the brush which lasts from 150 to 180 hours and costs $14 for each.

The sweepings are removed from the side of the pavements by special contracts for the different districts; and this carting away is completed before 8:30 A. M. in summer and by 9 A. M. in the winter.

A description of the removal of house refuse will be dealt with in another number.

The New Explosive "Kinetite".

According to a paper recently read before the Society of Chemical Industry, of England, by Mr. Watson Smith of Manchester, the substance "Kinetite" can be easily and safely mixed and transported, and when detonated in open spaces confines its action to the parts in contact only.

It is a German patent and manufactured in Germany by Messrs. Petry & Fallenstein. It is plastic, and as originally described consists of 16 to 21 percent. of nitro-benzene, in which from ¾ to 1 per cent. of gun-cotton is dissolved so as to form a jelly; from 75 to 82½ per cent. of alkaline chlorates or nitrates are then mixed in with from 1 to 3 parts of antimony pentasulphide.

It has from five to six times the explosive power of gunpowder, and is of a pasty consistency that will permit shaping by the hand without danger; confined in a tube by a close-fitting plunger surmounted by a weight of 187 pounds, the kinetite is simply compressed, and neither friction by rotation nor the blows of a heavy hammer on the weight would bring about an explosion. The materials may be transported separately and mixed when required, and it is impervious to water.

Aqueduct Commission.

At the meeting of January 19, the Commission passed the bill of W. H. McQuail for $463 41, in return for services and expenses as an expert in reporting upon the ventilation and lighting of the shafts and tunnel of the New Croton Aqueduct. By recommendation of the Chief Engineer forty new Inspectors of Masonry are to be appointed. Frederick W. Post was recommended to an appointment as Assistant Engineer, and Wm. D. Kelley, Jr., was temporarily appointed to the same grade. At the meeting of January 22, the Commission rejected all bids for the 135th street Gate House, owing to informality in the invitation for proposals, and directed that the work be re-advertised. The Secretary was directed to insert the date of opening of bids in copies of all instructions to contractors before giving out the same to parties desiring to bid on any work.

PERSONAL.

Our readers will please notice change of location of the EDISON MACHINE WORKS, advertised on another page, from 121 Chambers St. to 19 Dey St.

IRA A. SHALER, FREDERICK W. FROST, T. L. MOORE, P. L. PLAYLE and H. H. BOWLY were appointed Assistant Engineers on the New Croton Aqueduct on February 2nd.

HAROLD W. KEEFER, C. E., eldest son of Thos. C. Keefer, Mem. Am. Soc. C. E., was accidentally killed on January 22 on the line of the Ontario Pacific R. R. Mr. Keefer was supervising engineer of the bridges under construction at St. Anne and Vaudreuil on the road mentioned. In the line of his duty he missed his footing while descending from the top of a truss and fell to the ice below, his head striking the stone pier; at first his wound did not appear serious and he walked to the station and returned by train to St. Anne. But he died in about twenty-four hours from concussion of the brain. The deceased was 28 years old, and graduated from the Royal Military School at Kingston in 1880. He had been employed on Engineering works in the State of Missouri for some time before entering on the duty in the fulfillment of which he lost his life.

MR. HENRY COPE WHITEHOUSE, who will be remembered by all members of the Am. Soc. C. E., who attended the Buffalo Convention, has, according to Austrian reports, actually succeeded in enlisting the Egyptian Ministry of Public Works in his project for restoring Lake Mœris. This Lake excavated about 1350 B. C., was over 400 miles in circumference and in parts 300 feet deep. It served as a storage reservoir for the overflow of the Nile in periods of high water, and gave back this reserve in time of low Nile to irrigate the land and increase the flow in the river. It is now reported that engineers are to make a careful survey of the region with a view to prove the theories advanced by Mr. Whitehouse, and if these are found correct to take steps towards restoring this huge engineering work of the ancient Egyptians to its in valuable original purpose.

American Society of Civil Engineers.

The evening session of the annual meeting of the Society, on January 19, was devoted to the reading and discussion of a paper by Mr. Charles MacDonald, of the Union Bridge Co. on the very interesting testing machine which we illustrate herewith. (See page 91). In order to be able to give this illustration we were compelled to postpone the conclusion of our report for one week. The reading of the paper resulted in a very animated discussion.

The machine itself is, we believe, the most powerful in the world, being designed to exert a pull of 1,200,000 pounds, or 600 tons, and has been actually used up to a tensile limit of 1,223,760 pounds. An immense eye-bar for the Hawkesbury bridge, 8 x 2 inch, 11 feet 7⅛ inches long originally and which stretched over 2 feet in breaking under a strain of 1,025,920 pounds, was exhibited at the meeting. The machine has been quite largely used for similar tests and so far with the most satisfactory results. The great Watertown machine, designed by A. H. Emery, and the only one which approaches closely to this in power, has a capacity of only 800,000 pounds in tension and 1,000,000 in compression. The Kellogg machine has not yet been adopted for compressive strains, but arrangements for doings, so, are in a forward state of preparation.

As compared with the Watertown machine the advantage of the one illustrated is that it is both very much cheaper and quicker and simpler in use, it being able to rupture almost any piece which can be admitted to the machine at a single stroke. Its disadvantage is that it is admittedly not quite so accurate, or rather so precise, in its readings, the Watertown machine being almost absolutely exact. On the extent of this disadvantage and of the possible inaccuracy the discussion of the evening turned, the general purport of the discussion being that the inaccuracy was probably only a fraction of one per cent., and at any rate far within the limits of uncertainty of the material, so as to be in every way well suited for practical requirements.

The main details of the machine itself are very clear from the engraving. The hydraulic cylinder is left entirely open at one end for inspection and was designed to be of such diameter as to expose an effective pressure area of exactly 2,000 square inches, so that the pressure in pounds per square inch would indicate without correction the tension in tons. Actually it is of 2,039 square inches area (4 feet 3¾ inches diameter) and 4 feet 11 inches working stroke. The maximum water pressure for which the machine is designed is 600 pounds per square inch, which produces strain in the various parts of the machine of

Main girders.....	7,100 lbs.	compression	per sq. in.
Steel castings.....	15,000 "	"	"
" "	13,000 "	tension	"
" connecting rods...	1,5000 "	"	"
" bolts.....	1.2000 "	shear	"

The piston will be seen to have four piston rods connected with it, for reasons of convenience which are obvious enough from a study of the engraving. The whole point of dispute and doubt in regard to the practical accuracy of the machine lies in these packings, which are somewhat different from that which has been heretofore used for packing hydraulic cylinders of this character. The ordinary hemp packing in general use is used, with a gland of substantially the usual form. This packing was carefully set up by the bolts until the leakage under maximum pressure was reduced to a thin film of water discharging uniformly around the periphery. After completing a test, the piston is brought back by opening the discharge cock, and the suction of a head of 4 feet 6 inches, (or 1½ pounds per square inch of piston) suffices to bring it back. This is equal to 3,000 pounds total pressure, which is believed to be nearly constant, and the maximum which should be allowed for friction, being under 0¼ per cent. of the highest strain, which for practical purposes may be neglected.

A pump with three single-acting plungers, 2¼x10-inch stroke, working at slow speed, supplies so steady a pressure that little or no fluctuation is observable in the gauges.

In using the machines the tail-block is attached to the nearest suitable range of holes, the block B^3 is then adjusted by the spindle E, the test-piece is lowered to place by a traveler, the connecting pins driven in, and pressure applied. The gauges rise uniformly, but at a certain point cease to move, which is taken to indicate permanent set. At the ultimate tension they remain stationary, often for a considerable time. At rupture they begin to fall, at first slowly, then very rapidly. Small check valves prevent injury to the gauges. The main girders of the machine are 60 feet long by 3 feet 5⅝ inches high, built of plates, and angles rolled in one length. The holes for attachments are 6¼ inches in diameter, and 18 inches apart, the thickness of the web along this part being 2½ inches; the main girders rest on 12-inch cross girders bolted to masonry.

The tail-block A is a steel casting, the connection block B^3 resting on wheels. The rods D^2 are held fast in the block B^2 by double nuts, while they are free to push through the tail block A. The recoil is therefore controlled by friction on the rod H, which is regulated by the clamp I. The pin-hole is 7½ inches in diameter and slotted 1½ inches to permit of recoil of the test piece itself. This recoil is taken up on a wooden block placed back of the eye-bar. At the other end no arrangements for receiving the recoil are necessary.

The cylinder head is packed by a copper wire, as shown by the enlarged view. The further details of the machine hardly need more description than the engraving itself. It was constructed and is now in use at the Athens, Pa., works of the company.

After a somewhat fuller description of the details of the machine, and its workings, than it has appeared necessary to give here, the paper ended with a decided touch of sarcasm in reference to the difficulties which civil engineers had found in making the government machine at Watertown of practical use. Notwithstanding the fact that the express purpose for which the Watertown machine had been constructed was the making of accurate tests on large pieces of structural material it was alleged that the delays in tests were very great, often from four to six months, and that the officers in charge objected in effect to making tests approaching the full capacity of the machine. The Watertown machine was therefore declared in the paper to be "in all probability, destined to occupy quite an honorary position in engineering science, and to be quite beyond the reach of engineers in the active practice of their profession," so that individual enterprize had been the only remaining resource.

Discussion.

The first discussion was a written one from Maj. F. H. Parker, in charge of the arsenal at Watertown. After a complimentary reference to the testing machine described in the paper, he stated that the paper was founded on misapprehension as regards the present status of the Watertown machine, so that the comments on the latter were unwarranted, and its "laments gratuitous." He then stated that during the years since it was built 14,000 specimens had been tested, ranging in stress from 1 to 800,000 pounds, and in length from 1 inch to 31 feet 6 inches, the limit of the machine being 32 feet 4 inches for compression, and 37 feet 3 inches for tension. The gross amount of stress required to rupture those specimens, which ranged between 100,000 and 800,000 pounds had been over 125,000 tons. All forms of wrought-iron columns, large cast-iron columns, brick piers from 8x8 inches to 16x16 inches of various lengths and laid in various ways, and numerous tests of wooden posts had been made. Extensive tensile tests of riveted joints and eye-bars had also been made, the latter showing that stresses beyond the elastic limit caused a temporary reduction of the limit of elasticity from which the metal recovered after a period of rest. The effect of temperature up to 700 degrees had likewise been tested, and the strength of wire and hemp rope. "In view of this record of work done there was no reason to suppose that the government machine was going to cease to be useful, or quite beyond the reach of engineers in the active practice of their profession."

Mr. G. Bouscaren thought it very fortunate that there was now within reach an available machine, capable of testing full size bridge members of steel. The rapid increase in the use of this metal required that much of the elaborate experimental investigations of past years should be done over again. The close relationship of the two metals was a dangerous snare to those who would reason from our knowledge of one as to the other, but it was clear that steel should be one of our best servants, "possessing, as it does, in an exalted degree, all the best qualities of iron in addition to some very precious and valuable of its own." Its delicate nature, however, made it apt to surprise its friends by very strange behavior where iron would be entirely trustworthy.

He had undertaken lately to have some steel eye-bars tested at Watertown, but was told that the larger bars could not be tested there, the officer in charge being adverse to straining the machine anywhere near to its full capacity, and that the smaller bars could not be tested for six months. It was, therefore, only too true that this machine, on which so many hopes were founded, was "quite beyond the reach of engineers in the active practice of their profession;" and that private enterprise should have stepped in and filled the gap, was a legitimate subject of congratulation. No shop could be considered fully equipped without a testing machine of at least 500 tons capacity.

Mr George S. Morison had found the same difficulty in utilizing the Watertown machine. At first the management of it had been all that could be asked for. It was very costly, but did excellent and prompt work. The tests for the Plattsmouth, Bismack and Blair Crossing bridges had been made at Watertown, but recently the delays had been so great in getting tests made, as to make the machine practically useless. The reports on the last sets of bars he had sent had only been received several months after the bridge was open for traffic, nor did they appear disposed to use greater strains than 300,000 to 400,000 pounds. The Athens was the only other accurate machine. No lever machine anywhere in the country exceeding 100 to 150 tons strains was of the slightest use. It was a great advantage of the Athens machine that it would break almost any specimen at a single stroke. He did not know precisely how accurate it might be, but for most practical purposes he believed it was accurate enough. The tests for the new Omaha bridge, and for a new 400 feet span for Oregon, he had had made on this machine, with very satisfactory results.

Mr. A. H. Emery, the designer of the Watertown machine, stated that there was certainly urgent need for a smaller machine at Watertown for ordinary testing, and an appropriation therefor was likely to be made. He thought that it was a highly dangerous assumption that the packing friction in the Athens machine could be entirely neglected. Such friction was not only very uncertain, but was far larger than was generally supposed, and far larger under heavy work than when the piston was unloaded. It did not follow that because suction alone would return the unloaded piston to place, that there might not be 5 to 10 per cent. lost by friction when loaded. The cylinder was very likely to be distorted likewise under the heavy pressure, and so add greatly to the piston friction.

To remedy this difficulty Mr. Charles E. Emery had devised a system for keeping the piston constantly rotating during a test, which enabled a very small force to move it longitudinally. They had found that this apparatus, with the piston

moving, indicated - - - - - - - - - -	310,000 lbs.
And with the piston at rest - - - - -	290,000 "
A *difference* of - - - - - - - - - - -	20,000 "

What the absolute friction in each case was, no one can tell.

Gauges were also a source of error. He had found a guaranteed gauge indicate 600 pounds when the actual pressure was 525. Gauges would not rise and fall the same, but always read higher with a falling pressure than with a rising. He then gave a very interesting account of his method of testing gauges, and suggested that a large bar might be tested to some strain under the limit of elasticity, and then re-tested at Watertown. A large bar would give a very accurate dynamometer.

Mr. Theodore Cooper thought Mr. Emery greatly over-estimated the danger of packing friction in such a machine as this. In small machines, it was a serious matter but not in large machines. Results in tests for the St. Louis bridge, which he had had charge of, and which for the most part had never been published, proved this. For all practical uses he believed the Athens machine was more reliable than the Watertown, since it broke pieces at a single stroke. The possible danger from distortion was something he was not ready to express an opinion on off-hand.

Mr. Charles E. Emery felt about the machine like the young lady in the song, "I like it; I like it; I do." The friction of ordinary hydraulic packing, made of leather, was very great, but in this case he thought the whole difficulty had been gotten over, and that the higher the pressure the less would be the friction, because the more perfectly would a film of water interpose between the packing and the cylinder.

In answer to questions by Mr. Cooper and others, Mr. Macdonald stated that in making tests a thin film of water could be seen from the open end of the cylinder escaping uniformly around the periphery of the piston. The Shaw mercurical gauge was used, which they felt satisfied was accurate. Mr. Cooper stated that with the 24-inch hydraulic piston at St. Louis, they had found the loss to be about 1 per cent. Less formal discussion and questions continued for some time, and its general purport appeared to indicate that the machine was entirely trustworthy for practical work, its margin for frictional error beyond that allowed being very small.

Excursions.

On the second day of the Annual Meeting a special train of the very handsome cars of the Suburban Rapid Transit Company, over the Second avenue, elevated was taken at Twenty-third street, which ran without a stop to the present terminus of the company's lines at 147th street. Here the "trunk" line branches out into three extensions, one of which is now being pushed rapidly forward, with good prospects for the early construction of the others. As we have now in preparation a fuller illustrated description of this company's lines and works, we will not here enter into any detailed notes of the admirably solid and substantial construction of the line so far completed and in progress, which is a vast improvement on the New York elevated lines and reflects great credit on the Chief Engineer, Mr. J. J. R. Croes, and the Consulting Engineer for bridges, Mr. Theodore Cooper, by whom the iron work was designed. These gentlemen, as also Mr. S. R. Filley, President, and Mr. Wetmore, Superintendent of the line, accompanied the party. Notable deviations from past practice are the solid brick piers in place of iron, except at the street crossings, where space could not be spared; the carrying of the line to a large extent through purchased right of way instead of the streets; the use of plate instead of lattice girders, of heavier rolling loads, and of longer spans of 40 to 45 feet. A peculiar system of stiffening the all-iron structure from the top instead of from the bottom has been introduced by Mr. Cooper, and appears to possess decided advantages. The ties and guard rails are all creosoted. Much heavier locomotives are used than on the New York lines, weighing 41,500 pounds on drivers, 54,500 pounds in all, against 28,000 to 35,000 pounds. The line completed is 0.88 miles, with 1.33 miles under contract, and some fifteen miles in three nearly parallel lines projected. The stations, and in fact the whole structure, have an admirably neat and workmanlike appearance, showing evidence of careful design.

On the return trip, a stop was made at the Harlem river draw-bridge, designed by Mr. Cooper and illustrated and described by ENGINEERING NEWS early in last year. The ingenious and novel method of working the draw (which is now in use however on several other bridges) is working very satisfactorily, as was shown practically on the spot.

A steamer was then taken to the Greenpoint Iron Works, the property of Vice-President Thomas F. Rowland, who has shown in many ways so much interest in the Society. The original *Monitor* was built at these works, and the original drawings, as well as drawings of various torpedo-boats and other later works, were exhibited in the spacious drawing room, which is one of the finest, if not the largest in the country. A spacious lunch was also exhibited, which was inspected practically with general interest, and the works then visited in parties of twenty, under escort of members of the staff. The most noticeable peculiarity of the works is the large extent to which gas is used for welding large cylinders by means of portable tuyeres. By placing one under, and one over the weld a welding heat is very quickly obtained, and while it is not claimed to be much cheaper than other methods, it is economical in quality of welds and saving of time. The works are very busy.

The great Statue of Liberty, which we have already thoroughly described, and illustrated, was then visited, and on the following day small parties visited the Tenth avenue cable road, Brooklyn Bridge and a coal-storage warehouse under it, and the works of the New York Steam Heating Co.

Regular Monthly Meeting, February 2.

The meeting of the Society on Wednesday was not very numerously attended, owing to the inclemency of the weather. President Worthen presided.

Mr. Geo. G. Anderson, Chief Engineer of the Northern Colorado Irrigation Co. presented a very interesting and practical discussion of Mr. Dorsey's paper on Irrigation. He dwelt on the absolute necessity of storage reservoirs, both because of the greater demand for water and because the season of greatest supply was becoming every year earlier.

Current allowances of 50 per cent. loss for evaporation and seepage were undoubtedly excessive as Mr. Dorsey said, and yet often occured. In the Denver Water Co's canal the measured loss was 50 and 52 per cent., but its construction was not of the best. On the High Line Canal, he had found that at two points forty-five miles apart, the volume of water had been as 156 to 80, during the hottest and dryest weather, and on very proous soils. This loss should gradually diminish but to estimate less than 25 per cent. would hardly be wise.

The present duty in Colorado was 56 acres per cubic feet per second, as stated, but this could be materially improved. The exact quantity of water should be measured and not sold in gross. Mr. Dorsey had tersely and well stated the financial benefits of irrigation. Good farming land within ten miles of Denver was worth $75 to $100 per acre. Drainage should accompany irrigation and was too much neglected.

Mr. E. E. R. Tratman submitted some full and valuable notes on "Irrigation in Spain" from a paper by J. P. Roberts, 1867. As much as $175 per acre was often spent for the works, making the land worth from $625 to $750 in the rare cases when it is sold. In others it was rented at $46 to $50 when neighboring irrigated land would only bring $2 to $3. A canal starting from a weir, or even from the natural level of the stream above some rapid fall, was the usual plan. Norias or irrigation wheels were much used. Some important mistakes in level had been made by which it was found after completion that water would not run up hill.

The paper likewise gave interesting details of the construction of the works, which we cannot give in full. From 1.3 to 5.3 gallons per minute per acre was allowed. The formula $V = 51 \sqrt{I R}$ in which V = velocity (inches per second, we infer) I = incline and R = hydraulic mean depth, was considered most reliable. The velocity was 23½ to 27½ inches per second, and the favorite grade 12½ to 19 inches per mile. The radii of curves at these velocities should not be less than 492 feet, if slopes are unprotected. If pitched with stone, 65 feet may be used. The more important canals are cleaned out every year, at a cost of $40 to $80 per mile. The total expense per acre as $30 to $42; or in some cases of costly canals $75.

A note from Mr. A. D. Foote presented a recent Arizona decision that owners of irrigation lands have inalienable rights to the water supply, though they have no ownership in the ditch.

The Secretary also read a paper by Professor J. A. L. Waddell on "Specifications for Strength of Iron Bridges"; Mr. Waddell referred to the practice of working out strains to a fine point, the precise basis for which was little better than guess work. He thought a few empirical rules would be simpler and more practical. He also referred to the question of uniform specifications and thought that while a general specification might be made to cover ordinary work, special specifications should be drawn up for extraordinary work, such as cantilevers, long spans and braced piers. In a brief discussion on this paper Mr. Macdonald stated that at a recent conference, while the manufacturers were able to decide upon a standard, it was found impossible to get the engineers to give up their individual ideas; he did not think a uniform system of specifications probable or advisable, as the science of bridge building is growing and changing so rapidly that such specifications would be useless in a few years' time. Mr. Theodore Cooper considered manufacturers entirely disqualified from making specifications, comparing them to the apothecary who makes up prescriptions written by the doctor. He thought that bridge buildings had not advanced to that stage at which a uniform specification would be desirable, and added that if he had to construct a bridge and assume the responsibility, he would want that bridge constructed according to his own ideas. He asked, further, if engineers had yet decided upon uniform specifications for masonry, a much older branch of the profession than iron bridges? The general impression seemed to be that bridge designing and building was a very simple and easy matter, and that it was only necessary to draw up a standard specification in order to enable anybody to design and build a bridge. President Worthen made some interesting remarks on the old timber, single tracks, Howe truss bridges on the Boston & Albany Railroad (on the old line from Springfield to Boston) the trusses of which were set farther apart in a double track alteration. This was about 1859.

Before adjurning, the President referred to the irregularity of the time at which the meetings are called to order; he desired a certain time set, and after a little discussion 20:15 was settled upon by an almost unanimous vote; at which time the meetings will be called to order in future.

The following members were found elected at the meeting:

MEMBERS:

CHARLES ACKENHEIL, (Pol. Tech. School, Karlsruhe, 1863), engaged as Assistant, Principal Assistant and Chief Engineer on extention and branches Baltimore and Ohio Railroad: now Chief Engineer Baltimore and Ohio Railroad, New York extension, (Baltimore and New York Railroad and Staten Island Rapid Transit Railroad) Elizabeth, N. J.;

GEORGE MEADE BOND, (Stevens Ins. 1880), Mechanical Engineer in charge of Guage and Standards Department. Pratt and Whitney Co., Hartford, Conn.

JOHN WILLIAM FERGUSON, (Elected Junior February 2d. 1881.) formerly Assistant Engineer New York, Lake Erie and Western Railroad in charge of the construction of various work; now Assistant Engineer of Bridges and Buildings, New York.

ALEXANDER MACKENZIE, (West Point 1864), formerly Assistant Engineer Improvement of Harbors of Lake Michigan. Improvement Falls of Ohio River and Louisville and Portland Canal: Harbor of Refuge on Lake Huron: Improvement Detroit River; Construction Standard Light Rock House on Lake Superior; now Major Corps of Engineers, U. S. A., in charge of Improvements on Upper Mississippi River, Rock Island, Ill.

JOHN WILSON RUTHERFORD, engaged in Construction Dubuque (Iowa) System of Water Works; Water Works in Memphis, Tenn.; Terre Haute, Ind.: Newport Ky.: Atlanta, Ga.; Engineer and Contractor ninety miles Columbus and Toledo Railroad; Chief Engineer, St. Joseph (Mo.) Water-Works; now engaged in general Engineering and Contracting and Consulting Engineer Greenwich and Portchester Water Works, New York City.

GEORGE HUNTINGTON THOMPSON, formerly Assistant Engineer in charge extension Oswego and Syracuse Rd.: Resident Engineer New Orleans, Mobile and Texas Rd.; recently Assistant Engineer, New York Central and Hudson River Rd.; now Engineer of bridges New York Central and Hudson River Rd.

SAMUEL TOBIAS WAGNER, (Univ. Penna., 1881), formerly engaged as Heliotroper, U. S. Coast Survey, Draughtsman, afterwards Assistant Master Mechanic and now in charge Bridge and Roof Shops, Phœnix Iron Co.

ROBERT EDWARDS WILLIAMS, (Univ. Mich. 1874), formerly Assistant Engineer, Boston and Lowell Rd.: Assistant Engineer, Lawrence (Mass.) Water-Works: in charge of location and construction of Filter Gallery Pump Station, etc., Newton (Mass.) Water-Works: Resident Engineer, Jackson and Ohio Rd.: Chippewa Falls (Wis.) Water-Works: Engineer for Street Grades, Charlotte (Mich.); now Resident Engineer in charge of Rochester (Minn.) Water-Works.

CHARLES POPE YEATMAN, formerly Resident Engineer, Cincinnati Southern Rd.; Resident Engineer, Cincinnati and Portsmouth Rd.; Engineer in Charge, Antioquia Rd. in U. S. Columbia; in charge of location and preliminary lines, Norfolk and Western Rd.; now Chief Engineer, Girardot Rd. in U. S. Columbia.

JUNIORS:

EDWIN DUBYEA, JR., (Cornell Univ., 1883), Assistant Engineer, Bulo Bridge, Bulo (Neb.).

CORYDON TYLER PURDY, (Univ., Wis., 1885), City Surveyor, Eau Claire (Wis.).

EMANUEL SCHONEY, (School of Mines, Columbia Coll., 1884), Assistant Engineer, Department of City Works, Brooklyn (N. Y.)

[Names of five members and four juniors, we may add, are on the current ballot list, to be canvassed, March 2, and eight members and two juniors on the current "blue-list" of candidates].

Illinois Society of Engineers and Surveyors.

The second annual meeting of this society was held at Champaign, January 26, 27 and 28, 1887. The presidential address by I. O. Baker, Professor of Civil Engineering, University of Illinois, consisted of a summary of engineering progress during the past year. A considerable part of the address was devoted to fuel; the speaker directed the attention of the society to the subject of fuel, its importance in view of the immense increase of manufactures, and of the great wastefulness of solid fuel, and the great comparative economy of gaseous fuel. Of the natural gas supply in Illinois the opinion was expressed that although natural gas might continue to be found in household quantities, it would probably cut no figure for industrial uses, even if it held out for domestic purposes. From this conclusion he made the possible exception of a small district near Litchfield, forty or fifty miles northeast of St. Louis, it now being used in 400 stores in that town; in other parts of the State the gas is from the drift, but in Linchfield deep-seated, with conditions somewhat similar to that under which the Pittsburg gas is found. He stated that he found it impossible to collect reliable data as to the amount of ditching done in the State; fourteen steam dredges had been operating in the State during the year, the total amount of open ditches cut by other means, in the aggregate greatly exceeds that cut by steam, and the tile laid in 1886 was estimated by the tile-maker's convention at 50,000 miles.

The Legislative Committee reported in favor of the license system for surveyors, civil and mining engineers; that all surveyors be recorded at public expense; and that the law in reference to recording surveys of mines be better enforced. The other standing committees made elaborate reports of the matters committed to their charge, but which cannot be briefly summarized.

Combined vs. Separate System of Sewerage for Small Cities, S. A. Bullard, City Engineer, Springfield, elicited much discussion as to the best way of ventilating sewers. The views expressed in The License System of Surveyors, Samuel S. Greely, Civil Engineer, Chicago, were concurred in and a committee appointed to secure a law licensing surveyors. Topographical Surveyors and Records for Drainage Purposes. C. G. Elliott, Chief Engineer, Red River Valley Drainage Commission, Tonica, and Field Work in Drainage Engineering, A. H. Bell, City Engineer, Bloomington, fully and ably covered the entire field work of drainage and surveying. In the former the usual day's work in leveling was six miles of main line, and one mile to check with parallel line, the maximum error permissible was $\frac{1}{10}$ of a foot for the seven miles, but usually the agreement was much closer than this. Just Apportionment of the Cost of Drainage Improvements, D. J. Stanford, County Surveyors, Shatsworth, showed that the problem was one of the greatest complication of which only an approximate solution could be obtained. During the discussion the opinion was expressed, that drainage matters were of such importance, and so complicated, that a State Commissioner should be appointed, whose relations to drainage matters should be somewhat similar to those of the State Superintendent of Instruction to the schools.

Exterior Boundary of Townships, F. Hodgman, author of Surveyors' Manual, Climax, Mich., and Fractional Sections, J. A. Emos, Surveyor, Springfield, and Decision of Questions in Practice in Land Surveying, led to prolonged and animated discussions as to the best method of reconciling irreconcilable inconsistencies, Perpetuation of Corners, J. S. Burt, County Surveyor, Henry, and Importance of Accurate Measurement in Surveying, D. L. Brancher, Civil Engineer, Lincoln, showed how these difficulties could have been avoided, but were not.

Railway Trestles, E. A. Hill, Acting Chief Engineer, I., D. & S. R. R., Indianapolis, Ind., was an elaborate and carefully illustrated account of the method of designing, constructing and repairing these structures. Illustrated Lecture on Bridges, I. O. Baker, Professor Civil Engineering, Champaign, was a semi-popular account, accompanied by lantern views, of the development of bridge building in America. Reservoirs for Railroads, Mills, etc., S. F. Balcom, Assistant Engineer I. C. R. R., Champaign, explained a cheap and easy method of constructing puddled dams and reservoir walls.

Oil and Natural Gas in Illinois, T. B. Comstock, Professor of Mining Engineering, Champaign. The professor finds many evidences that the little gas that has been discovered in Illinois does not come from the drift, though found in it, and believes there are strong probabilities that fair supplies of both gas and oil will yet be found when proper borings are made. He referred to the Litchfield district, to an area adjoining a line running southeast and northwest through or near Champaign and Urbana, and a field near and north of Lasalle, as being full of hope for oil and gas, while there is much of the State where there can be neither. The lecture was well illustrated by maps and charts and gave an intelligent view of the possible wealth yet to be developed in these lines.

Pavements for Small Cities, Geo. F. Wightman, City Engineer, Peoria, and the discussion which followed was of very general interest. Mr. Wightman exhibits a sample burned clay block, about 4 by 5 by 14 inches, of which he has laid on experimental section of pavement in Peoria; the block, apparently, is as hard and strong as granite, mathematically accurate in form, and running absolutely uniform in quality. This pavement is laid upon a natural bed of sand, overlaid by an artificial coating of gravel about 4 inches thick to afford drainage, and "after seven months service is as level as a floor." A. H. Bell, City Engineer, Bloomington, presented some bricks taken from the pavements of that city after having been in use fourteen and nine years respectively. When laid the brick did not run uniform in size, and hence it was not possible to determine exactly the wear; for those in service fourteen years the wear was certainly not more than half an inch, and probably not more than one-quarter. At present manufacturers are making a much better brick than these; it appears to be the prevailing fashion to chamfer off the corner of the face slightly.

In point of attendance the meeting was counted very successful, sixty-two members, several contractors, etc., being in attendance; although organized only a year ago, this society has already taken a front rank in associations of a like character in this country. The officers for the ensuing year are:—

President, I. O. Baker, Champaign; *Vice-President*, J. T. Foster, Chicago; *Executive Secretary*, A. N. Talbot, Champaign; *Recording Secretary*, S. A. Bullard, Springfield; *Treasurer*, G. P. Ela, Bloomington; *Executive Board*, C. G. Elliott, *Chairman*, Tonica, A. H. Bell, Bloomington, T. B. Comstock, Champaign. The next meeting is to be held in Springfield in January, 1888.

Register of Attendance.

I. O. Baker, Professor of C. E., University of Illinois, Champaign; J. S. Burt, Surveyor, Marshall County, Henry; D. J. Stanford, Surveyor, Iroquois County, Chatsworth; G. P. Ela, Bloomington; F. B. Kyle, Champaign, Surveyor, Champaign County; Daniel Gordon, Moline; Z. A. Enos, Springfield; A. H. Bell, City Engineer, Bloomington; G. T. Wightman, City Engineer, Peoria; C. G. Elliot, Chief Engineer, Red River Valley Drainage Commission, Tonica, Ills.; A N. Talbot, Assist. Professor Engineering University of Illinois, Champaign; G. M. Clark, Low Point; Richard Gray, Bloomington; E. A. Hill, Acting Chief Engineer, I. D. & S. R. R. Indianapolis; C. W. Clark, U. S. Engineer, St. Louis; S. A. Bullard, City Engineer, Springfield; L. N. Sizer, Dickerson; D. L. Brancher, Lincoln; T. B. Comstock, Professor of Mining Engineering, University of Illinois, Champaign; S. F. Balcom, Assist. Engineer, I. C. R. R., Champaign; L. P. Thompson, I. C. R. R., Champaign; J. Withington, Mattoon; D. W. Mead, City Engineer, Rockford; T. S. Mc Clanahan, Monmouth; J. T. Foster, Chicago, Surveyor Cook County; J. R. Lewis, Piper City, Surveyor, Ford County; S. S. Greeley, Chicago; G. V. Loring, City Engineer, Decatur; S. C. Colton, Chicago; H. A. Stevens, Chicago; F. V. Alkire, Petersburg; Thos. Dunn, Bement; C. H. Dickerson, Charleston; B. J. Gifford, Rantoul;

Liverpool Engineering Society.

The usual fortnightly meeting of this society was held at the Royal Institution, Colquitt street, Liverpool, on Wednesday, January 12th; Mr. J. J. Webster, M. Inst. C. E., president, in the chair. A paper by Mr. A. W. Brightmore, M. Sc., entitled, "The Flow of Water," was read by the author. The author commenced by pointing out that the present theory of hydrodynamics is only applicable to one form of motion of water, and that the least prevalent in nature from an engineering point of view. After explaining under what circumstances this was the case, and on the other hand the conditions of motion to which it did not apply, he went on to describe the motion of water under three conditions which most commonly present themselves to the engineer—viz., the motion of water in streams, in pipes, and the motion of ships in water. With regard to the first of these three, the theory was of but little use, and empirical laws of various degrees of complexity had been proposed, of which he mentioned the one of easiest application, and giving results probably as accurate as the others.

In describing the motion of water in pipes, he pointed out that when the velocity was slow enough, the motion came under the present theory; but after attaining a certain critical velocity, depending *ceteris paribus* inversely on the size of the pipe, the motion became sinuous, and an empirical law had been found to express the flow under these conditions. This law, owing to the more restricted conditions under which the flow took place, was of a more definite nature than in the case of streams. Proceeding to the motion of ships in water, after describing Froud's experiments on the resistance of plane surfaces moving through water, and his experiments on H. M. S. Greyhound and a model of the same, he went on to point out that the resistance of ships in water was due to three causes, which were skin friction, dead water eddies, and the energy imparted to the water to produce waves. He concluded by showing how the resistance of a full-sized ship at different speeds can be inferred from that of a small scale model run at corresponding speeds with very great accuracy.

ANSWER TO CORRESPONDENCE.

K. V. W., Hazelton, O.—The Mexican National are said to be about to complete the gap in their main line. H. H. Filley, Chief Engineer, Mexico. The Mexican Central extensions are more doubtful. E. W. Jackson, Gen. Manager, Mexico. The announced line to Tuxpan is a very doubtful matter. It is unlikely that there will be any great activity in Mexico in the near future.

WATER.

Toronto, Canada.—During the past year the amount of water pumped was 4,323,774,305 gallons, an increase of 786,291,707 over 1885.

The United States Automatic Water Cut-Off Co., of Atlanta, Ga., has increased its capital stock from $50,000 to $200,000. The incorporators are W. G. Brown, W. A. Hemphill, T. P. Westmoreland and John Keely.

Grand Rapids, Mich.—W. R. Crow and W. F. Inman, representing the American Loan & Trust Co., of New York City, have been in the city to close the negociations which have been pending for some time for the purchase of the city water-works by an eastern syndicate.

Rahway, N. J.—The superintendent of the water-works has submitted his semi-annual report, with a summary for the past year. During the year 247,749,101 gallons of water were pumped; the cost of pumping 1,000,000 gallons into the mains, exclusive of repairs, was $10.56. Sixteen new iron valve boxes were substituted for wooden boxes. Thirty new services have been put in, making a total of 608.

Memphis, Tenn.—It is stated that the insurance companies who lost by the recent fire at the compress shed will institute suit for $300,000, the amount of their loss, against the Mississippi & Tennessee R. R. Co. and Memphis Water Co. It is alleged that the fire originated from a spark from one of the engines of the railroad company, and that the water company had given permission to the railroad company to shut off the supply of water from the fire-plug in the immediate locality of the fire without having notified and obtained permission from the chief of the fire department. The first fire engine that arrived at the scene attached its hose to this plug, but could not play on the fire for want of water.

Jamestown, N. Y.—The troubles between the water company and the city have culminated. The public water supply has been condemned by the Board of Health. The account presented by the company, amounting to over $3,000, for furnishing water for fire protection for the past six months, has been repudiated by the Council, and the water company has sued the city for the amount. Should the company further retaliate by refusing to continue the supply of water for fire protection, the city would be almost without means of putting out fire; hence the situation is a very serious one. Both sides seem determined to fight the case out in the courts.

Vincennes, Ind.—The final test of the water-works was made on January 25th; six fire streams from hydrants in any part of the town were required to be thrown to a height of 100 feet for ten hours. Both stand-pipe pressure and direct pumping were used alternately. Lowest pressure (stand-pipe), 86.7 pounds; highest pressure (direct pumping), 150 pounds; average steam gauge, 102 pounds; total revolutions of engines, 11,696; water pumped, 696,360 gallons; average height of stream, 119 feet; highest stream, 147 feet. The test was satisfactory and the works were accepted by the City Council. The pumping station is located on the bank of the Wabash river, just above the city; at ordinary stages of the water the supply is taken direct from the river, and in time of high water from two large filtering wells sunk in the gravel formation. There are two compound, condensing, vertical-acting, pumping engines, with a daily capacity of 2,000,000 gallons per day each; they were built by the Deane Steam Pump Co., of Holyoke, Mass. The suction main is 20 inches in diameter and the force main 18 inches. There are three tubular boilers, 18 feet in length and 60 inches in diameter. The engine house and smoke-stack are of brick, the latter is 100 feet in height. The stand-pipe is 22 feet in diameter and 200 feet in height. It differs from the usual type in having a novel system o

inside bracing. The pipe system consists of 14.2 miles of 6-inch to 18-inch cast-iron pipe, with 150 double-nozzle fire hydrants and 49 valves. The works were built by Messrs. Samuel R. Bullock & Co., of New York City; E. F. Fuller, M. Am. Soc. C. E., of New York City, was the Chief Engineer.

WATER SUPPLY ON THE PLAINS.—The method of supplying a large range with water by pipes from storage reservoirs at Silver City, N. M., is working admirably. There is a constant and ample supply of water. A wooden dam that is to be put in at once, will increase the storage. One tank holding 110,000 gallons is in place and full. The pumping apparatus is efficient. Two smaller tanks are being built, yet the machinery need be run but one day in the week to fill them. The pipe from the pump to the tank is 6 inches in diameter, and the distance is 3,500 feet. From the tank a 3-inch pipe runs about a mile before there is a fork. Then one branch runs due south six miles, while another goes west nearly ten miles, each tapering until the terminus is reached, and there the size is only 1 inch. From the west line a branch leads off south half a mile to a point about equally distant from the termini of the two main lines.

Along the pipe lines, groups of troughs already on the ground, at intervals of a mile, are being placed. At each location for a trough there is a T in the pipe. A float attached to the valve opens it whenever the water is lowered by cattle drinking. The pipe is the best made, dipped in asphaltum at the foundry and painted since being delivered. The troughs are 20 feet long, 2½ feet deep, 18 inches wide at the bottom and 26 inches at top. The pipe is laid about a foot under the ground and will never be damaged by freezing.

The south branch is on the Pacific slope, being separated on the continental divide. The three tanks will supply water for 12,000 head of cattle, and additional tanks may be used. The end of the south pipe is 600 feet below the level of the tanks, which are 300 feet above the town. With all the T connections open the quantity of water coming out the end does not seem decreased. At the west terminus, near the Mongus road, the depression is not so great. These improvements have cost over $60,000. The plan was completed several years ago, but the work was commenced only last spring. Thus a range of 300,000 acres is supplied with water for the cattle to drink. Except near town, the land has never been grazed upon, because there was no water.

NEWBURG, N. Y.—At a special election held January 27th it was decided to request the Council to issue $37,500 water bonds. The water-works committee reported that in view of the unsatisfactory condition of the water some means of purification was necessary. The report states that this can only be done by thorough filtration and aeration; the report is very favorable to the Hyatt filter, of which it says the main features are as follows:—"The coagulants, which may consist of sulphate of alumina and solution of lime, will be fed into the water not to exceed two grains of each to the gallon. The water then passes to the first aerating apparatus, then through inlet pipes to the filters, entering above the filtering material, consisting of one part coke to two parts sand, it percolates down through the same and is conducted to the second aerating apparatus, where it receives a second aerating and then flows into the reservoir, and thence into the pipes leading to the city. By a simple and effective plan the filter beds are thoroughly cleaned every 24 hours."

A report of an analysis of Little Pond water states that the effect of the Hyatt process is to reduce the organic putrescible matter of the water to a small proportion of the original amount and to remove from it a multitude of low organisms, both animal and vegetable, to which its objectionable qualities are principally due. The Newark Filtering Co., J. W. Hyatt, President, has made the following proposition, "We will tap your main pipe near the small (Monell) reservoir leading the water to the enclosure surrounding said reservoir, and upon the grounds, by the side of the reservoir, to erect three filters, each 20 feet in diameter. We will also place one of our patent aerators at a point near the inlet to the filters, and also two automatic coagulant feeders. The water thus comes to be coagulated and aerated before it reaches the filters. From the filters the water goes to a second aerating well, where it is again charged with air under pressure, and flows to the reservoir. Our price for the above mentioned plant will be $31,500. We have made repeated tests of our process upon the water of your city and will guarantee bright, clear and wholesome water, at the rate of 2,500,000 gallons per 24 hours."

The expense for alterations at the reservoir, etc., will bring the total cost up to $37,500. As the material in the filter beds is washed daily the services of one man will be required to attend to this work. The coagulants and renewal of filtering material will cost about $700 per annum. In comparison with the above the first cost of the ordinary filter beds would be about $55,000 and the annual cost of maintenance at least $2,500 per annum. The well-known fact that the filtering material very soon gets completely charged with the organic and vegetable matter in the water, even with the best of care, and the impossibility of washing the material, except at a great expense, is to the committee a sufficient reason for advising strongly against the last named system for filtering the water. The cost for the necessary plant for filtering the water by the Hyatt system, viz: $37,500, will not increase the water rates to provide for this expenditure.

Professor Challoner, who has inspected the process and made analyses of the water reported that the system worked with entire satisfaction at Somerville, N. J.; about one-third of a grain of alum is used per gallon, this is absorbed by the filtering material and the filtered water does not contain a trace of the alum. Prof Challoner states that the system would certainly be successful at Newburg and concludes his report with the opinion that the process is simple, efficient and economical and that no objection can be found to it on sanitary grounds; while the only alternative would be a system of filter beds, which are more expensive to construct and maintain and do not give as satisfactory results.

During the past season the water mains have been extended 1,638 feet, and 2,000 feet of pipe is on hand for further extensions as soon as the weather will permit. The high-service reservoir has been completed and several repairs and extensions made.

WHITE PLAINS, N. Y.—A committee from the board of fire underwriters visited the town recently to inspect its means of fire protection, and after a test by the fire department expressed themselves satisfied that the supply was ample. The pressure was derived from the water tower and the offer of the water company to put on direct pumping pressure was declined as it might burst the hose. The consequence of the examination is that the committee has reduced the insurance rates 33⅓ per cent. The water is obtained from a gravel formation about 30 feet below the ground. The well is 20 feet deep and from the bottom a number of pipes are driven down to the gravel: it is lined with brick and will be roofed in. The pumping engine is a high-pressure, duplex, Worthington engine; 18-inch cylinders, and 12-inch pump plungers; it has a daily capacity of 1,000,000 gallons; there are two steel boilers of 100 H. P., manufactured by the Watertown Steam Engine Co. The iron water tower is 20 feet in diameter and 80 feet high; it was built by Riter & Conley, of Pittsburg, Pa. There are about 5.5 miles of distributing pipe, 740 tons of cast-iron pipe; about 40 connections have already been made. The works are now in operation. The works were constructed by Messrs Moffett, Hodgkins & Clarke, of Watertown, N. Y.

DRAINAGE IN ILLINOIS.—Champaign county has several of the largest ditches in the State, which were excavated during the past few years under the provisions of the State drainage law, and still other ditches are needed. The latest project is a fifteen mile ditch in Colfax and Sadoens townships, the excavation to be made at a cost of 9¾ cents per cubic yard. Pallard, Goff & Co. have been awarded the contract, and they will use a large steam dredge. Work will begin as soon as the frost is sufficiently out of the ground. This ditch will empty into the famous Lake Fork ditch, completed two years ago.

An important case has been under consideration at Lincoln, Ill. Several persons have petitioned to have Sugar Creek widened for a distance of ten miles to reclaim swamp lands. Several remonstrances were made to the petition. The scheme is to construct a canal ten miles in length and 60 feet in width, which if carried out will entail a cost of $300,000.

The drainage commissioners of District No. 1, St. Clair county, have awarded the contract for the drainage of 10,000 acres of land, subject to overflows during freshets, to Mr. Nueidlekamp, of Belleville, who agrees to furnish a pumping outfit of 20,000,000 gallons daily capacity, at a cost of $5,950 to the district. Two 10,000,000 gallon centrifugal pumps will be used, with two 30-H. P. boilers and other parts in proportion. The pumping station will be located at the flood gate on the dyke, one and a half miles west of Cahokia. The area in question drains naturally when the river is low, but slowly, and the object is to draw off the water promptly coming from the high grounds back of the dyke.

SEWERAGE.—Yonkers, N. Y., is in great need of the proposed system of sewers that will render the purification of the Nepperhan possible. The measure meets with considerable favor.

At St. Louis, Mo., an ordinance has been adopted providing for the acceptance of a general plan to drain that portion of the extended limits of the city which is at present naturally drained by the Mill creek and River des Peres. The sewers may not be built for several years but the plan is to be made before the district is built up. Other sewers are contemplated.

At Philadelphia, Pa., the districts served by the Wingohocking creek and Gunner's run have asked the Council to make appropriations for walling in and covering these waterways which receive the sewage of the districts: as they are very offensive and dangerous to health.

Green Island, N. Y., is to be bonded for $75,000 for the construction of a sewerage system; the bill designates Michael Keatink, Thomas H. Richardson, James Dwyer, John M. Deal and Wm. Shannahan as sewer commissioners.

At Boston, Mass., the Sewer Department asks for $50,000 to make provisions for drainage by Stony brook in order to prevent floods in Roxbury: this is part of the work that was reported upon last year by James B. Francis, Eliot C. Clarke and Clemens Herschel. A determined effort is to be made to push the matter in the Council and in the Legislature.

At Toronto, Canada, the city engineer has reported on two plans for draining Rosedale. The first proposal is for a sewer to carry the sewage proper and the summer flow of the creek. It would connect with the culvert at Tannery Hollow and extend to Gerrard street, where it would connect with the River street sewer, and would be a part of the main sewerage system of the city. The storm water would flow as at present through the old creek channel. The second proposal is for a sewer to commence at the same point, and to be carried along the flats to the Don, where it would end. The size of the first sewer would be 30 inches by 45 inches, egg-shaped; its length, 10,680 feet; and its approximate cost $75,000. The size of the second sewer would be 84 inches, circular; its length, 9,000 feet, and its approximate cost $125,000.

FORT MEADE, DAK.—The Secretary of War has laid before the Senate the recommendation of the Quartermaster General on the subject of better water supply. The Quartermaster General suggests the purchase of four lots in McMillan's addition to Sturgis City, containing certain springs, and the construction of a pipe line to the post, half a mile distant, to convey palatable water from these springs. The water for the post has heretofore been drawn from Bear Butte creek, but mining operations near its source and the location of the town on its banks only two miles above the post has, from drainage, etc., polluted the water of the creek to such an extent as to forbid its use for domestic purposes, and at times the arsenic and other mineral solutions with which it is impregnated from the reduction works in the hills unfit it for any purpose. The question appears to be a vital one and should be met as early as practicable: Gen. Ruger, at St. Paul, urges the early consideration of this matter by congress. An appropriation of $5,000 for the purchase of these lots is recommended, and the construction of a pipe line about 3,000 feet in length, which will cost about $1,700, to convey the water to the fort.

IRRIGATION DITCH.—The Colorado Coal & Iron Co. is making preparations to reconstruct and open the ditch from six miles above Pueblo, Col., to the St. Charles river, six miles below town. This ditch will put under irrigation about 15,000 acrse of land that is now valueless. The cost will be about $75,000.

TAUNTON, MASS.—The Water Commissioners have issued their report for the year ending November 30, 1886, this being the eleventh annual report. The supply has been sufficient, the pumping machinery has performed its work with regularity and the distributing system has been extended by rather more than the usual quantity of main and service pipe. The maintenance and construction accounts show satisfactory balances. The report in dealing with the advisability of increasing the supply, refers to its communication made in May 1885, stating that the open filter basin was an unsatisfactory portion of the system and after mentioning other cities where a fishy or cucumber taste has been experienced, quotes Prof. Nichols' report to the city of Springfield, Mass., recommending that all filter beds be covered, the sun and light being necessary for the development of the vegetable organisms which by their decay injure the taste of the water. Mr. J. J. R. Croes, M. Am. Soc. C. E., recommended the covering of the reservoir. The committee submits plans for the construction of a semi-circular brick arch 11 feet in diameter and 20 inches thick, over the bottom of the basin, and the filling in over this arch to the level of the cap stones, or about half the height of the embankment. By this means the water will be under cover at low stages of water, and the supply will be drawn from the arch. The cost of the work including extra pumping during construction, while the basin is dry, is estimated at between $9,000 and $10,000. While the present pumping machinery is of ample capacity for ordinary purposes, additional power is recommended for fire protection; the rotary pumps are recommended to be taken out when a new engine is put in.

During the past season 4.37 miles of main have been laid, making a total of 52.91 miles; 2.12 miles of service pipe, total 26.22 miles: 35 hydrants, total 457; 40 gates, total 318; 4 blow-offs, total 20; 226 service taps; 83 meters, total 680; 25 per cent. of the taps now in use are metered. The pressure has had to be increased to give the required supply to the State Lunatic Hospital, increasing the coal consumption about 9 per cent. It is recommended that 3,600 feet of 16-inch pipe and 2,000 feet of 12-inch be laid. A brick workshop has been constructed. The total pumpage for the year was 292,539,158

gallons, an average daily consumption of 773,531 gallons. The population is estimated at 23,674, of which 18,000 are supplied. The distribution pipe is cast-iron, from 4 inches to 20 inches diameter; the service pipe is cement lined wrought iron, from .75 to 1.5-inche diameter.

NEWS OF THE WEEK.

PROPOSALS OPEN.

Grading.—By sections, 60 miles of the Chicago, Santa Fé & California R. R. McArthur Bros., Keokuk, Ia.

Grading and Masonry.—For two additional tracks on the New York Division, (1) from Bear Swamp to Monmouth Junction, 7 miles; (2) thence to Millstone Junction, 8 miles; (3) from additional tracks four Metuchen to Menlo Park, 1¼ miles. Bids per cubic yard. Wm. H. Brown, Chief Engineer, Pennsylvania R.R., 233 S. Fourth street, Philadelphia, Pa. February 10.

Filling.—White sand, gravel, earth and loam, for the Concourse lowlands. Separate bids per cubic yard. Office of the Park Commissioners, City Hall, Brooklyn, N. Y. February 10.

Water Pipe, Etc.—Cast-iron water pipe, 4,116 feet of 6-inch, 1,524 feet of 8-inch, 6,864 feet of 10-inch; special castings, 22,000 pounds; 4, 6, 8 and 10-inch valves, 17 hydrants. City Clerk, Kalamazoo, Mich. February 10.

Grading.—Double-track railroad for the Shellpot branch. Wm. H. Brown, Chief Engineer, Philadelphia, Wilmington & Baltimore R. R., 233 S. Fourth street, Philadelphia, Pa. February 12.

City Hall.—Wm. Walters, architect. Robert Brand, Chairman of Building Committee, care of City Clerk. Oshkosh, Wis. February 14.

Paving.—Asphalt paving and granite curbs. Board of Public Works, St. Paul, Minn. February 14.

Iron Fence, Stone Work, Etc.—For approaches to the court house at Harrisonburg, Va. Office of the Supervising Architect, Treasury Department, Washington, D. C. February 14.

Tow Boat.—For the Mississippi river improvemnt. Capt. E. H. Ruffner, U. S. Engineer Office, Quincy, Ill. February 14.

Dredge Scows.—Two side-dumping dredge scows. A. Gobeil, Secretary, Department of Public Works, Ottawa, Canada. February 14.

Water-Works. For Knoxville, Ia. Plans and specications prepared by A. A. Richardson, C. E., Lincoln, Neb.; amount to be expended $19,000. City Clerk, Knoxville, Ia. February 15.

Iron-Work.—Beams, columns, girders, etc., for custom-house at Richmond, Va. Office of the Supervising Architect, Washington, D. C. February 16.

Street Work.—Curbing, crossings and sidewalks for 1887; R. M. Clayton, City Engineer. M. Mahoney, Commissioner of Public Works, Atlanta, Ga. February 21.

Jail.—Stone jail, brick and stone residence, steel cells, etc. Architect, S. Floyd Hoard, Ceredo, W. Va. M. S. Bartram, Auditor of Lawrence county, Ironton, O. February 23.

Contracting.

Iron Beams.—The following proposals have been received at the office of the Supervising Architect, Washington, D. C., for iron floor beams for the public building at Clarksburg, W. Va.: Clark, Raffler & Co., $1,218; Dearborn Foundry Co., $1,225; Snead & Co. Iron Works, $1,286; J. F. Osborn's Sons, $1,290; Marshall Foundry & Construction Co., $1,341.50; C. M. & J. B. Hart, $1,481.50; L. M. Morris, $1,596.61.

Joiner Work.—The following bids have been received at the office of the Supervising Architect, Washington, D. C., for joiner work at the public building at Jefferson City, Mo.: Cudell & Lehmann, Chicago; oak, $15,976; pine, $12,584; John Moore, Syracuse, N. Y., $18,600. $16,800: Robert Mitchell Furniture Co., Cincinnati, O., $19,325, $19,025; James W. Givens, Chicago, $23,996, $19,750: John H. Coster, Baltimore, Md., Baltimore, Md., $22,550.

Barges.—The following proposals have been received at the office of the Mississippi River Commission for the construction of eleven barges: James Mask, Cincinnati, O., $1,975 each; Alfred Cutting, Metropolis, Ill., $2,450; Thos. P. Morse, St. Louis, Mo., $2,560; E. J. Howard, Jeffersonville, Ind., $2,600; Mississippi Valley Marine Railroad & Dock Co. Cairo, Ill., $2,950. The government limits the price to $2,000 each.

Cable Conveyor.—The Trenton Iron Co., has received a contract from the Cobb Lime Co., Rockland, Me., for a tramway to Doherty's quarry for the transportation of rock from the quarry floor to the top of a bank 100 feet high. The tramway will consist of two steel cables 1,200 feet long each, on which will run a carriage, to which is attached a tub which can be lowered into the quarry. The carriage and tub are operated by a hoisting engine.

Water and Gas Works.—At Socorro, N. M., the contract for a system of water-works, complete, has been awarded to George H. Woolston, of Boston, Mass., for $30,000 in 6 per cent. bonds for 20 to 30 years. The works are to be completed by May 1st.

The contract for gas works has been awarded to W. H. Patton, representing the Denver Water Gas Co. The works are to be commenced in 90 days and to be completed within twelve months.

City Contracts.—At Louisville, Ky., proposals will be opened to-day for cast and wrought-iron, stoneware pipe, footway crossing, cleaning wells, repairing wooden pumps and galvanized iron tube wells, broken stone, block stone, flag stone, curbing, gravel, corner stones, broken stone screening, bowlders, hardwood blocks, lumber, sand, brick, cement, lime, rolling with steam roller, hardware, and cement pipe.

Water-Works.—The following proposals were received for the entire work for the water-works at Junction City, Kan.: Cook & Heaton, Junction City, Kan., $46,893; G. W. Cadigan Morgan, Chicago, Ill., $47,617; Fairbanks & Co., St. Louis, Mo., $57,722; Northwestern Water-Works and Gas Supply Co., Minneapolis, Minn., $59,797. The contract has been awarded to Messrs. Cook & Heaton. Deane pumps, Chapman valves and Matthews hydrants will be used; the pipe will be manufactured by Shickle, Harrison & Howard. J. B. Johnson, of St. Louis, Mo., is the engineer.

A New Zealand Cement.—After many trials this far-off section of the world is producing a really good hydraulic cement of its own. Messrs. Wilson & Co., of Mahurangi, near Auckland, are now turning out an article that under tests by the Lyttleton Harbor Board only broke at a tensile strain of 588 pounds to the square inch for pure cement. It has had six months trial with excellent results. The works can at present turn out 20 tons per week and it is sold at about $3.75 per cask. Increased facilities for production now under construction will probably reduce this price.

Steam Hoister and Pile Driver.—The following proposals were opened January 31, by S. T. Abert, U. S. Agent, Washington, D. C., for a combined steam hoister and pile driver for improvement work on the Roanoke river, N. C.: John Myer's Son, Washington, D. C.; derrick scow and attachments, $1,725 (exclusive of boom seat, turntable, capstan and windlass); additional lighter scow, $425; $150 extra will be charged for delivering boat and scow at Plymouth, N. C. H. T. Morrison & Co., Petersburg Iron Works, Petersburg Va.; additional lighter scow, $675; complete plant, $5,264.47. Sam W. Skinner, Wilmington, N. C.; additional lighter scow, $750; complete plant, $7,775. Jas. B. Haliday & George Cumberland; derrick scow and attachments, $3,011; additional lighter scow, $735; complete plant, $5,611.

Pier. — Proposals were opened February 2d at the Department of Docks, New York City, for removing a part of the pier at the foot of W. 34th street and building a new wooden pier: John Gillies, $56,524; Joseph Walsh, $56,580; P. Sanford Ross, $58,500: James D. Leary, $65,620; Barth S. Cronin, $71,600; W. P. Kelly, (informal). The contract was awarded to John Gillies. The engineer's estimate was $54,000.

The following are the quanties of material from the engineer's estimate: dredging round cribs, 14,000 cubic yards; crib dredging, 8,400 cubic yards; yellow pine timber, various sizes, 339,735 feet B. M., measured in the work; white pine, yellow pine or spruce timber, 4,732 feet B. M.; spruce timber, 83,613 feet B. M.; white oak timber, 8-inch by 12-inch, 8,512 feet B. M., (these quantities of timber are exclusive of extra lengths for scarfs, laps, etc.; and waste); yellow pine, white pine or cypress piles, averaging 80 feet in length, 658; white oak fender piles, about 55 feet long, 14; Square and round wrought-iron dock spikes and 40 d nails, 35,000 pounds; boiler plate armatures, 11,830 pounds; wrought-iron screw bolts, 16,000 pounds; cast-iron washers, 8,495 pounds; wrought-iron straps, bolts and washers 1,017 pounds; cast-iron mooring posts, 14,380 pounds; 1-inch iron wire rope, 23 feet; painting, oiling and tarring; labor of removing old pier, and for 27,788 square feet of new pier. The repairs to the inner end of the old pier will require, yellow pine timber, 70,711 feet B. M.; white pine, yellow pine or spruce timber, 1,556 feet B. M.; spruce plank, 45,120 feet B, M.; white oak timber, 8-inch by 12-inch, 2,016 feet B. M.; square wrought-iron dock spikes and 40 d nails, 10,783 pounds; wrought-iron screw bolts, 1,247 pounds; cast-iron washers and cleats, 1,022 pounds; painting, oiling and tarring; labor for repairing 40,980 square feet of old pier.

City Work.—At Cleveland, O., the Board of Aldermen has decided upon a considerable amount of grading, curbing and street improvement.

At St. Paul, Minn., sewer and street work has been authorized and the clerk of the Board of Public Works has been instructed to advertise for proposals.

At Little Rock, Ark., an ordinance has been passed laying off a new paving district and work will be commenced shortly; block paving will probably be adopted. For further information address the city engineer.

At Port Chester, N. Y., the village trustees have awarded contracts for the construction of sewers in Westchester avenue district and Highland avenue district to Freeman H. Merritt,

At Cincinnati, O., the clerk has been directed to advertise for proposals for street work.

Water Works Plant.—The following proposals have been received at Oberlin, O.—(1) Two pumping engines of 1,000,000 gallons capacity each; Knowles Steam Pump Works, New York City, $6,210; Gordon & Maxwell, Hamilton, O., $6,379; Deane Steam Pump Co., Holyoke, Mass., $6,815; Holly Manufacturing Co., Lockport, N. Y., $7,400; Geo. F. Blake Manufacturing Co., New York City, $7,890; Henry R. Worthington, New York City, $8,200.

(2) Hydrants and valves, and water gates, (70 hydrants 6-inch gates); Coffin Valve Co., hydrants, $26 each, gates $13.50; Ludlow Valve Manufacturing Co., $26 20, $14.76; Galvin Brass & Iron Works, $26.50, $13.50; Unite l States Pump & Valve Co., $26.60, $13.50; Wm. Bingham & Co., $26.83, $12.75; James Flower & Bros., $27, $12; Eddy Valve Co., $28, $13.90; Bourbon Copper & Brass Works, $29, no bid; Holly Manufacturing Co., $30, $13.70; Chapman Valve Co., $30.85, $14.15; W. F. Otis (Matthews hydrant), $31.48, $10.78; R. D. Wood & Co., $31.50, $15.52; Rouse & Hills Co., no bid, $10.80; Lord, Bowler & Co., no bid, $16.50.

(3) Cast-iron water pipe: Buffalo Cast Iron Pipe Co., $32.50 per ton; Lake Shore Foundry, $33.45; Jackson & Woodin Manufacturing Co., $39.75 (per ton of 2240 pounds); Cincinnati & Newport Iron & Pipe Co., $40; Dennis Long & Co., $40.75; Shickle, Harrison & Howard $42,

(4) Pipe laying, (6-inch pipe): Philip Sullivan, Fremont, O., 18 cents per lineal foot; Homegarden & Conley, Sandusky, O., 18¾ cents; W. F. Otis, Norwalk, O., 18 3-8 cents; J. C. Ross & Co., Elyria, O., 18¾ cents; W. H. Myers & Son, Hillsdale, Mich., 19¾ cents; Snyder & Williams, Dayton, O., 20 cents: Oberlin Gas Light Co., Oberlin, O., 21 cents, W. M. Chisholm, East Liverpool, O., 21 cents; R. B. Caruthers, Newport, Ky., 22 cents; John C Harlow, Pittsburg, Pa., 22 cents; J. J. Rumsey, Canton, O., 22 cents; H. N. P. Dale & Co., Columbus, O., 22¾ cents; Adam Miller & Co., Rome, N. Y., 28 cents; M. McKean, Sandusky, O., 29¾ cents; J. E. Magraw, Liberty, Va., 31 cents.

New Croton Aqueduct.—The following proposals for the construction of Shaft No. 15½ were opened by the Aqueduct Commissioners on February 2nd. The Commissioners will hold a meeting at 3 P. M., February 7th, at which the award will be made:

	O'Brien & Clark. New York City.	John A. Lee. Crawford, N. Y.	George E. Clark. New York City.	Engineer's Estimate.
Shaft excavation. 125 lineal feet.	$ 140	$ 100	$ 110.00	$ 80
Brick masonry for shaft lining and arches. 200 cubic yards	11	11	12.00	13
Concrete masonry, 1 cement: 5 stone. 100 cubic yards.	5	5	4.50	6
Concrete masonry, 1 cement: 3 stone. 75 cubic yards.	6	6	5.30	7
Rubble stone masonry. 15 cubic yards.	5	5	4.00	5
Cut stone granite masonry. 10 cubic yards.	40	40	40.00	30
Shaft filling. 550 cubic yards.	25 cents.	25 cents.	75 cents.	75 cents.
Total.....	$21,262.50	$16,262.50	$17,865.00	$14,512.50

Masonry.—The following bids have been received at the office of the Superyising Architect, Washington D. C., for masonry of basement and area walls for post office building at Lexington, Ky.: Belknap & Dumesnil Co., (Bowling Green sandstone), $9,250; John Boyle, (Georgia granite), $9,800, (Georgia marble), $10,000, (Indiana limestone), $10,300, (Indiana limestone and Georgia marble), $10,400, (Woodstock granite) $10,700, (Indiana limestone and Woodstock granite) $11,100 (Kentucky sandstone and syenite granite), $11,400, (Indiana limestone and syenite granite) $11,800; David Y. Johnson (Bedford) $9,941.65; Dumesnil & Bro. (Bedford), $9,975; John Diebold, (Salem sandstone) $10,500; McCarthy & Corbett (Kentucky sandstone), $12,537, (Bedford) $13,147; Lexington Brick Co., (Bedford), $13,909.23; John Moore, (Bedford), $17,514.

The Hale Pavement Co. has been organized at Staunton, Va.; capital stock, $150,000. President, Capt R. H. Catlett; General Manager, Gen. T. L. Rosser; Secretary, Major J. Hotchkiss.

Hydrants.—At Milwaukee, Wis., the contract for 100 double steamer nozzle fire hydrants has been awarded to R. D. Wood & Co., of Philadelphia, at $40 each. The only other bid received was from Filer, Stowell & Co., of Milwaukee, for $43 each.

Levee Work.—The following proposals have been received by the Louisiana Board of State Engineers: Sutton & Williams levee; James Parker, 10.98 cents per cubic yard; J. Bentley, 13.5 cents; Ogden & Jones, 14¾ cents; Thomas O'Malley, 15 cents; Martin Head, 17 cents; R. M. White, 17.5 cents; J. B. McGinty, 23 cents; John J. Frawley, 27 cents.

Harvey Bayou dyke; Ogden & Jones, 14.72 cents; W. J. Bentley, 15 cents; T. O'Malley, 15 cents; R. M. White, 16¾ cents; Martin Head, 17 cents; J. J. Frawley, 27 cents; J. B. McGinty, 28 cents.

Bayou Rouge dyke; Ogden & Jones, 14¾ cents; T. O'Malley, 15 cents; John B. McGinty, 28 cents; J. J. Frawley, 35 cents.

Burton levee; W. Burton, 10 cents; T. O'Malley, 15 cents; P. Byrnes, 15.25 cents.

Hermitage levee; T. O'Malley, 15.75 cents; Ogden & Jones, 25 cents.

River Improvement.—The following proposals have been received by Lieut. Col. Wm. P. Craighill, U. S. Engineer Office, Richmond, Va., for work on the James river, Virginia: Lampkin & Langhorne, Richmond, Va.; dredging sand and gravel, 20 cents, $20,000; solid rock excavation, 10 cents, $22,500; disintegrated rock excavation, $1.50, $375; mattress dykes, $4.10, 41,000; extension of jetties, $4, $8,000; construction of jetties, $4.75, $9,500; total, $101,375. Isaac Boynton, Newport, R. I.: 20 cents, $20,000; 15 cents, $33,750; 15 cents, $3,750; $3.67, $36,700; $4.50, $9,120; $4.56, $9,120; total, $112,440. American Dredging Co., Philadelphia, Pa.: 20 cents, $20,000; 15 cents, $33,750; $1, $250; $5.50, $55,000; $5, $10,000; $5.20, $10,400; total, $129,400. John F. Gayner, Savannah, Ga., (dikes and jetties only); $3.47 $34,700; $3.47, $6,940; $3.47, $6,940. Frank Hefright, Huntingdon, Pa., (dikes and jetties only); $4, $40,000; $3.75, $7,500; $4, $8,000. John L. Johnson, Fulton, N. Y., (dredging and excavation only); 24 cents, $24,000; 8 cents, $18,000; $2, $500. George E. Ward, Georgetown, D. C., (dredging only); 15¼ cents, $15,000. Jos. Caler, & Son, Norfolk, Va., (dredging only); 17¾ cents, $17,250. Atlas Dredging Co., Wilmington, Del., (dredging only); 18 cents, $18,000.

Railroad Contracts.—Shephard, Winston & Co., of St. Paul, Minn., have been awarded the contract for the construction of the Chicago, St. Paul & Kansas City R. R. from Chicago to the Missouri State line. Work will be commenced at once.

Mr. Beemer has been awarded the contract for the construction of the Montreal & Occidental R. R.; the road will be built first to Ste. Agathe but will be extended to La Chute aux Iroquois and Notre Dame du Désert. The surveys have been started.

McMurtrie & Woodward, of Sault Ste. Marie, Mich., have been awarded the contract for the construction of the Antalle & Tench section of the Minneapolis, Sault Ste. Marie & Atlantic R. R.; the work will be sublet at once. Henry & Balch, who have the contract for the sections from Mill Lake to Minneapolis, and from Rhinelander to Saunder's Point, have put on 100 men to cut a road along the right of way.

E. C. Barron, of New York City, and Thomas Kingsley have each been awarded contracts for three miles of the Central Massachusetts R. R. between Northampton and Belchertown; the balance of the work will be done by J. Ryan.

Depot.—The Houston & Texas Central R. R. Co. has awarded contracts for the erection of a large union depot at Houston, Tex.; the brickwork was awarded to Barnes & Palliser, Galveston; carpenter work, A. C. Morin; galvanized iron and tin, C. Redding & Co.; plumbing and steam heating, Paul Shean; slating, E. Browne; painting, W. H. Louck. The plans were prepared by architect Geo. E. Dickey. The building will be 317 feet in length and three stories high; it will contain the offices of the president and other officers of the road.

Railroads, Bridges and Canals.

Railroad Consumption of Lubricants.—The *Railway News* figures the annual consumption of "oil and tallow" on the railways of the United Kingdom at about 14,800,000 gallons, costing $1,850,000. The same authority figures the average cost of "oil, tallow and waste" per train mile in locomotive running expenses at 0.133 cents.

Hudsons Bay R. R.—President Hugh Sutherland stated recently that the company would expend $1,000,000 this year in construction. Rails are being manufactured for 200 miles of road and locomotives are also being constructed. The company is having three steamers built at Newcastle-on-Tyne for navigation on Hudsons Bay. Mr. Sutherland promises that the road shall be completed in two years.

Electric Railroads.—At Birmingham, Ala., surveys for an electric railroad are being made by Messrs. Smith and Eastman.——At Bangor, Me., an electric railroad is projected by Messrs. Laughton & Clergue. ——At Carbondale, Pa., an electric railroad is projected by J. W. Aiken.——At Los Angeles, Cal., the electric railroad has been in operation since January 1st, and is working satisfactorily; it is three miles long, and was built at a cost of about $50,000 under charge of A. H. Hayward. A 30-H. P. engine and dynamo supply the power, and when the entire line is completed a 150-H. P. engine will be put in.——At Kansas City, Mo., the electric railroad has been considerably delayed by the recent burning of the car shed; the cars have to be repainted and the motors re-wired. As soon as the machinery is in working order trains of two cars will be put on; extensions are to be built this year.

Cable Railroads.—At San Jose, Cal., the San Jose & Santa Clara Cable Railroad Co. has been incorporated to build a line ten miles long from Santa Clara to Alum Rock; capital stock, $250,000; Secretary, T. S. Montgomery.——At Chicago, Ill., an official inspection of the experimental line on West Lake and 40th streets has been made, and a favorable report sent in; the cost of the system is considerably less than that of other cable roads. The North Chicago Street Railroad Co. will build the cable road in the La Salle street tunnel as soon as possible.——At Cincinnati, O., large quantities of rails, yokes and other iron work for the Mount Auburn cable line are being delivered; contracts will shortly be let for dummies and cars. The company is being sued for damages caused by blasting.——At Philadelphia, Pa., the Council will report favorably on the Smith bill authorizing the traction companies to use any means of traction.

Elevated Railroad.—At Cincinnati, O., a bill has been drawn up providing for the organizing of companies to build elevated railroads; maps, plans and specifications are to be filed with the Secretary of State, and the railroad commissioners are to personally inspect the routes and examine the designs. The gauge not to be less than three feet. The maximum fare is to be 10 cents for any distance less than 10 miles and one cent for each additional half mile. The bill has been presented to the Improvement Association. Civil Engineer Earnshaw is interested.——At Chicago, Ill., the Chicago Rapid Transit & Elevated R. R. Co. is acquiring right of way and it is said it will certainly be built on State street. The Chicago City Railroad Co. and parties interested in other State street schemes are vigorously opposing this project; the capital of the company is subscribed mostly from New York and Philadelphia.——At Boston, Mass., an elevated road is projected by citizens of Roxbury and Dorchester, it is to start from Milton.

Street Railroads.—At Woonsocket, R. I., it has been decided to use horse traction for the new line, electricity being considered too new a venture.——At Minneapolis, Minn., the railroad committee of the council has refused to grant a franchise to Randolph Burgess for a line on 31st street.——At Birmingham, Ala., the street railroad companies are laying double tracks.——At Dayton, Tenn., a street railroad will be built by W. G. Allen.——At Springfield, Mass., the street railroad company will probably build the West Springfield line. ——At Omaha, Neb., a new line will be built to South Omaha.——At Wilmington, Del., the Wilmington & Brandywine Street Railway Co. has given up its scheme, the City Railroad Co. having agreed to build the line. ——At Sheffield, Ala., the Sheffield & Tuscumbia Street Railroad Co. is being pushed rapidly and is to be in operation by the 20th inst.——A horse railroad is projected for Asbury Park, N. J.——The capital stock of the Savannah Street Railway Co., Savannah, Ga., is to be $10,000; with privilege to increase to $1000,000: the charter is not yet secured.——The Saratoga Street Railway Co. has been incorporated by Elias H. Peters, H. Smith and others, of Saratoga, N. Y.: capital stock, $60,000.——The Newton Street Railway Co. has been incorporated by J. M. Ragsdale, A. L. Greene and others, of Newton, Kan.; capital stock, $ 60,000.

St. Louis Bridges.—When the stockholders of the Carondelet Bridge Co. announced their willingness recently to transfer the stock to anyone desiring to carry out the project and build a bridge across the Mississippi at South St. Louis, it was thought that the business interests of that section of the city would take the matter up. Jay Gould, however, holds the key to the situation, and as long as he has control of the great bridge he will not have another built at Carondelet. Mr. Charles P. Chouteau, one of the largest property owners in South St. Louis, states that "when the Merchants' bridge is built, which it will be at an early date, then Mr. Gould will want a bridge at Carondelet and he will have it. Those who want to see the Carondelet bridge completed at an early date should encourage the Merchants' bridge, for in so doing they are hastening the construction of the Carondelet bridge."

New York Underground R. R.—It has been announced that the company will begin tunneling Broadway for a series of rapid transit lines as soon as a permit is granted by the Commissioners of Public Works. Mr. Edward Lauterbach has purchased $1,550,000 of the stock and thereby secured a majority of the stock and the practical control of the Vandenburgh charter; he has since raised $3,000,000 for a construction fund. President, E. Lauterbach; Treasurer, Col. Calvin Goddard; Secretary, L. H. Rullman; the United States Subway Co., which is to build the road, is represented by Col. R. R. Hazard, Richard Irvin, Jr., David H. Bates, President of the Baltimore and Ohio Telegraph Company; Heeman Clark, contractor; Henry Clews, S. L. M. Barlow, J. Coleman Drayton and John H. Davis. Of the old directors who comprise the Vandenburgh interest, Col. Origen Vandenburgh, George R. Blanchard, Henry D. Sedgewick, Nelson G. Waterbury, Samuel R. Campbell and Frank Loomis still continue in the new board, and complete the list.

The United States Subway Company, of which Col. R. R. Hazard is President, is connected, though not identical, with the New York District Railway Company, and the contract for the construction of the road has been assigned to it by Col. Vandenburgh, the original assignee. The United States Subway Company now controls four corporations possessing rights for underground roads, and these will be merged into a common interest, which proposes to gridiron subterraneous New York. The present charter only admits of a two-track road, which will be built on the automatic ventilating system, and will occupy a space underground 15 feet deep by 35 wide, which will be divided into two tunnels. The directors say they can begin work at once as they have no legal contest to delay them, and their plan is approved by the majority of the property holders along Broadway. The wide-reaching plans of the company also contemplate the simplification of the transportation of freight between this and adjoining cities.

The route of the New York Underground R. R. was defined by a decree of Judge Sanford in the Superior Court of this city in 1876. Commencing in the City Hall Park on the easterly side of Broadway, it proceeds on both sides of the City Hall to the entrance of the Brooklyn Bridge, thence under Centre street to Mulberry at a point between Bayard and Park; thence northerly under Mulberry to Bleecker street; thence under Lafayette place to Astor place, under Poole's Theatre to Fourth avenue, under Fourth avenue, Fourteenth street, and Union square to Broadway and Seventeenth street. There a bifurcation is made and one section proceeds northerly under the blocks to Twenty-third street, under Madison square, and thence under Madison avenue to the Harlem river. The other section runs under Broadway, Twenty third street, and Fifth avenue, and along and under Broadway to and through the grand circle at the southwesterly corner to Central Park.

Notice to Water-Works Contractors.

SEALED PROPOSALS, addressed to William A. Wadsworth, President of the Board of Water Commissioners, will be received by the Village of Geneseo, N. Y., up to 12 o'clock, M., of February 24, 1887, for furnishing the materials and doing the work indicated in the following description, and required by the notice and specifications on file in the office of said Board of Water Commissioners in the village of Geneseo, N. Y. The specifications will be forwarded to bidders, for two weeks prior to date of letting, on application to John Young, Civil Engineer, Geneseo, N.Y.

(1) For furnishing a Steam Pumping Engine, Boiler and Iron Chimney, with a capacity of 600,000 gallons in twenty-four hours.

(2) For the furnishing and delivery of 1,005 net tons cast-iron four, six, eight and ten inch water-pipe, and 24,000 pounds (special) castings.

(3) For the furnishing and delivery of 63 Fire Hydrants and 39 Stop Valves.

WILLIAM A. WADSWORTH,
President of Board of Water Commissioners.
JOHN YOUNG, Civil Engineer.
J. NELSON TUBBS, Consulting Engineer.
6-3t GENESEO, N. Y., February 3, 1887.

To R .R. Contractors.

We are prepared to let contracts for grading, to reliable contractors, in amounts to suit on sixty miles of the Chicago, Santa Fé and California Railroad in Iowa and Missouri.

Profiles, specifications and forms of contract can be seen at our office at Keokuk, Iowa, where all further information can be had.

The work is easily accessible from Keokuk, and contractors are desired to examine the same.

6-4t McARTHUR BROTHERS.